THE GLASS INDUSTRY

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REMARKS ON QUALITY CONTROL IN THE GLASS CONTAINER INDUSTRY

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This discussion will be confined mainly to the consideration of the possibilities of application of statistical quality control to inspection operations in glass container manufacture. No attempt will be made to consider the many applications of statistical methods to process control.

The possibilities of statistical quality control merit careful consideration by the manufacturer of glass containers. There are many examples of its successful application to other manufacturing processes. These examples show how the method has been of definite value in reducing production costs, either by reducing the number of rejects or by reducing the cost of inspection, or both. The results are tangible and cannot be disputed. There is another benefit of quality control which is less tangible but no less important. This is improved reliability of product which should result in reduced complaints and more favorable customer acceptance.

There are several points in common between glass container manufacture and the other processes which have benefited from statistical quality control. The products are made on automatic machines which would be expected to produce a continuous series of identical articles. Variations in product may be caused by changes in the stock fed for processing. Machine parts may wear. There may be characteristics in the machine which cause variations, such as "play" in or mismatching of parts. The machine may get out of adjustment. The operator may change the machine setting. All of these things can happen to a glass machine, so that the application of statistical quality control to glass container production should be possible, because these are the types of variations which have been handled successfully in other industries.

The glass container manufacturer is already familiar with the two types of information that are used for statistical quality control. One of these types is represented by bottle weight, a quantity which is measured, in ounces and fractions of an ounce. Bottle capacity measurement is another example of this type of information. The proper use of these results gives what is known as quality control by variables. The second type of information is obtained when go–no-go gauges are used. Either the container is passable or it is not. The information from these tests is used in quality control by attributes. The two methods differ in detail but their basic principle is the same—judging quality by samples as guided by the laws of probability. A small sample is used for control by variables but the units in the sample have to be measured. A larger sample is required for control by attributes, but the units can usually be evaluated quickly.

The application of statistical quality control techniques to inspection does not automatically insure improved quality. Basic improvement in quality has to originate in production, not in inspection. The orderly collection of information required in the use of statistical quality control permits study which can lead to quality improvement. Quality control should point out the existence of quality variation so that corrective steps can be taken.

Advocates of statistical quality control realize that there must be some sound reason for adoption of the method. Current inspection methods may be inadequate and may be unnecessarily costly. Generally speaking, imposing statistical methods on top of present methods is not desirable because there will be an added cost. It is preferable to substitute the statistical method for all or a part of the method being used. If the inspection procedures in force are doing the proper job and no savings can be foreseen, there is no reason for making a change.

Because statistical quality control is based on samples, it is not the equivalent of 100% inspection in theory, although it may be better than 100% inspection in prac-

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tical results. Complete visual inspection of each article manufactured almost invariably falls short of the ideal. When large quantities of goods are to be completely inspected, fatigue enters the picture with the result that some of the off-standard goods slip by. There is no assurance that any reasonable number of re-inspections will correct the situation. Inspection of samples instead of all of the ware allows a more careful consideration of the units which are to be examined, with better inspection to be anticipated.

There are two general ways in which statistical quality control has proved its value. In the first of these, the method is used to determine if the process is operating normally and if there is a trend which will eventually result in production of off-standard ware. This trend can be followed to determine when to make a corrective adjustment in the machine. To be fully effective, tests or measurements are made immediately after the operation is completed so that the necessary correction can be made before unacceptable ware is produced. Assuming that such a procedure has been followed correctly, it would seem unnecessary to make any further inspection or test on the quality which has been controlled.

The second method involves the inspection of samples of the goods after each step or series of steps in an operation to determine if the units are capable of becoming finished products of acceptable quality. Suppose a product passes through four or five steps in its manufacture. The inspection of a sample or samples after the second operation may indicate that some of the units are not capable of becoming an acceptable product. There is no point in going to the added expense of finishing these only to have them fail to pass the final inspection. The production is divided into groups or lots, and samples from each of these lots are inspected. On the basis of these inspections a decision is reached as to which groups need to be given 100% inspection to remove off-standard units before continuing the processing of these lots.

There are certain characteristics of glass container manufacture which would seem to limit the full effectiveness of inspection for corrective action immediately after forming. To complete the full manufacturing cycle, the glass must pass through the lehr. This represents a considerable time lag (½ to 3 hours, as extremes) between forming and inspection or testing. There are certain determinations which can be made on "set-out" or unannealed glass with less time lag. To do this, it is necessary to know the connection between the results on the unannealed ware and similar measurements made on annealed ware. Assuming that the "set-out" ware cannot be recovered, the only determinations which can approach the practical are measurements, i.e., "variables," because this technique can be applied to small samples. Dimensions, weight, capacity and wall thickness are some of the qualities which may, reasonably, be evaluated in this way, i.e., by measurement. Even though relatively small samples can be used, such a practice cannot be justified if the amount of ware which is sure to be lost by "set-out" is equal to or greater than the loss expected using normal practices. Some such scheme of early inspection should be considered if specification requirements or forming difficulties result in large losses which could be reduced by earlier corrective action. Suppose it is decided to set out five bottles from each mold every fifteen minutes. If the production rate is twelve bottles per mold per minute, the loss in the unannealed ware would be 2.8%, which is appreciable.

There is undoubtedly a certain amount of checking which could be carried out quickly enough so that the ware can be put in the lehr while still hot and thus salvaged. An inspection of hot ware at the machine would have even greater advantage from the standpoint of reduced time lag. Weights are frequently checked on hot ware, and gauges could be devised to measure critical dimensions. If tests are carried out at the machine for purposes of early corrective action, it should be remembered that furnace and feeder operation can affect the ware as well as what happens in the actual forming process in the machine.

The second type of application, that of step-wise control, cannot be too effective in continuous glass manufacture. Raw materials can be tested and corrective action taken, if necessary, either before or during weighing. From that point on, as the process is usually set up, the control is largely in correct handling and processing rather than testing of goods in process for the purpose of taking corrective steps which will influence the quality of the glass tested. There are many points in the process where samples can be taken for inspection and test. There may be difficulties in getting representative samples and testing them quickly enough to be able to take corrective action on the glass which was sampled. Taking such corrective action would be even more difficult. This statement is not intended to discourage process control in an attempt to prevent difficulty or to correct the condition which affects the glass which will be made the next shift or the next day, because such controls are effective and valuable.

A glass container is not a complete unit in itself. It becomes a part of an assembly of bottle, closure, label and content. It must fit the assembly tools—the filling line. These requirements result in certain dimensional specifications which must be met. The container must also have certain performance characteristics. Observance of other specifications is needed to insure performance. Inspection is the process of determining the ability of the production to meet specifications and attempting to eliminate off-specification units.

The degree of inspection usually depends upon the ease of meeting the specifications. A dimension that can be held within tolerance limits easily is not usually checked as often as one which is more difficult to hold. This is as true of statistical procedure as it is of practical operation. Some measurements are made on glass containers as a matter of routine, and the application of statistical treatment to the information already being taken may point the way to a reduction in the cost of making the measurements or may show how to improve their effectiveness.

Many qualities of glass containers are subject to 100% inspection. The adequacy of this inspection depends, to a certain extent, upon the proportion of off-quality ware being given the inspector. Statistical theory teaches that more thorough inspection is needed as defects increase. With particularly critical items, it may be desirable to subject a part of the production to a second inspection. Application of statistical methods to the problem will give a more sound basis for judging when re-inspection should be instituted. The pallet load of ware, if that is

(*Continued on page* 220)

A.C.S. TO MEET IN NEW YORK CITY FOR ANNUAL MEETING

From April 23 to 27, New York City will play host to the American Ceramic Society as it holds its 52nd Annual Meeting. Using the Hotel Statler as headquarters, a well-filled five days have been planned for the attending Society members. Other hotels suggested for accommodations in the vicinity of the Statler headquarters are the Hotel McAlpin, Hotel New Yorker and Governor Clinton Hotel.

Speaker at the General Session will be C. E. Kenneth Mees, Director of Research at Eastman Kodak Company, who will deliver this year's Orton Lecture. Dr. Mees is one of the world's outstanding authorities on the science of photography. Also at Monday's General Session will be featured a General Electric "House of Magic" demonstration. This "magic", mixing scientific information with entertainment, will include broadcasting music on a beam of light, lighting electric lamps with matches and an electric eye, controlling a model train with verbal commands, and many other seemingly "impossibles".

Division sessions will begin on Monday afternoon and will continue through Tuesday and Wednesday. On Monday night, the annual floor show and dance will be held and it is expected that this event will have its usual heavy attendance. Because of this, it is urged that those wishing to attend had better "come early".

Tuesday will feature the General Banquet to start at 6:30 which will be followed by dancing later in the evening. At the Banquet, President Hobart M. Kraner will give his report of the Society and new Fellows and Officers will be installed.

On Wednesday, an abstracters' breakfast, technical sessions and an A. S. T. M. Committee C-14 meeting will be followed by a Board of Trustees dinner. Thursday will be devoted to plant trips.

The ladies attending the annual meeting have had only one afternoon function scheduled for them in deference to their suspected greater interest in the New York department stores (poor glassmen!) and famed New York sight-seeing points. A get-together party has been scheduled for them on Monday afternoon and, with the exception of the general entertainment functions, the ladies will be on their own.

Since the Camera Club Salon details were reported in the March issue of THE GLASS INDUSTRY, there have been two changes in the awards offered. These are the addition of two new awards: the Walter J. Gitter Award which will be given for the best color slide transparency with an industrial ceramic interest, and an award consisting of pieces of art pottery from Dorothy R. Seader Company, Philadelphia, Pa., to be given for the best color slide transparency in the show. The Camera Club Dinner will be held on Sunday, the first day of the meeting.

The Keramos meeting will be held on Tuesday, April 26, although no luncheon or dinner has been scheduled for this year.

The Second Ross Coffin Purdy award will be presented at the General Banquet on Tuesday. This is the Society's highest award which can be earned by a ceramist and is given each year for the most valuable paper on ceramic technology published during the preceding year.

The Charles Fergus Binns Medal will be presented to the ceramist who has produced the most outstanding piece of ceramic artware or ceramic design. This medal is given by former students of Charles Fergus Binns.

The winners of the $1000 Ferro Enamel Corporation award will also be announced during the meeting.

Local Committees of the meeting are as follows: *General Committee*: Chairman, R. L. Danielson, Metal & Thermit Corporation, Carteret, N. J.; Aaron K. Lyle, Hartford-Empire Co., Hartford, Conn.; R. B. Sosman, Rutgers University, New Brunswick, N. J.; G. H. Jeffrey, Titanium Alloy Mfg. Div., National Lead Co., Paterson, N. J.; C. L. Norton, Jr., Babcock & Wilcox Co., New York City; W. W. Winship, Winship Silica Products Co., Freeport, L. I., N. Y.; A. Josephine Gitter, Whittaker, Clark & Daniels, New York City; Robert F. Sherwood, United Feldspar & Minerals Corp., New York City; George T. Morse, U. S. Gypsum Co., Metuchen, N. J.; John H. Koenig, Rutgers University; G. C. Betz, Metal & Thermit Corp., New York City; Irwin F. Zeiller, B. F. Drakenfeld & Co., Inc., New York City; Chester C. Treischel, R. T. Vanderbilt Co., New York City; Robert A. Barr, Carborundum Co., Fair Haven, N. J.; N. Johnson Kent, Johns-Manville Sales Corp., New York City; and H. B. Du Bois, Consolidated Feldspar Corp., Trenton, N. J. *Entertainment Committee:* Chairman, H. F. Kleinfeldt, Abbe Engineering Co., New York City; Irwin F. Zeiller and Robert F. Sherwood. *Women's Committee:* Chairman, Mrs. G. T. Morse, Miss Emma Nawrot, Mrs. H. B. Du Bois, Mrs. R. F. Sherwood, Mrs. S. J. McDowell, Mrs. W. W. Roff, Mrs. R. R. Danielson, Mrs. A. K. Lyle and Mrs. J. H. Koenig. *Plant Trip Committee:* Chairman, George C. Betz, John H. Koenig and H. B. Du Bois. *Information Committee:* Chairman, W. W. Winship, Josephine Gitter and G. H. Jeffrey.

Abstracts of papers to be presented at the Glass Division and several papers presented at the Refractories, Physical Chemistry, Materials and Equipment and Design Divisions follow:

GLASS DIVISION PROGRAM

Monday Afternoon, April 24, 1950
2:00-5:00 P.M.
Salle Moderne

1. Analytical Methods for Determination of Small Amounts of Colorants in Glass. *By Paul Close, F. C. Raggon and W. E. Smith, General Research and New Development Division, Owens-Illinois Glass Co., Toledo, Ohio.*

Data and a brief outline of the analytical method employed are presented on the precision and accuracy for estimation of trace amounts of Cr_2O_3, NiO, CoO, CuO and Selenium and Sulfide Sulfur in soda-lime glasses.

Amounts of colorant determinable are as follows:

Cr_2O_3	2—600 micrograms
CoO	2—100 micrograms
NiO	5—100 micrograms
CuO	5—80 micrograms
Selenium	0.0002% (approximate minimum)
Sulfide	0.005 to 0.10%

2. Diffusion of Ions in Simple Glasses. *By James R. Johnson, The Ohio State University, Columbus, Ohio.*

Thermal diffusion coefficients for the diffusion of a few ions in some simple glasses in limited temperature ranges have been measured using radioactive tracer techniques. These coefficients have been used to obtain the energies of

activation for the diffusion processes. Correlation of this information with other physical properties of glasses is made.

3. The Influence of Base Composition and of Minor Constituents on the Coloration of Carbon-Sulfur Amber Glasses. *By A. K. Lyle, Hartford-Empire Co., Hartford, Conn.*

The literature on carbon-sulfur amber glasses reveals a number of conflicting statements, most of which are unsupported by laboratory tests or factory observations. This paper presents the results from a large number of laboratory tests and cites supporting evidence from observations of commercial operations.

Contrary to generally accepted theory, both the intensity and stability of amber coloration are shown being favored by high silica and low soda contents. Using the same amounts of carbon and sulfur, color intensity is the same for all glasses in which the difference between the percentage silica and twice the percentage soda is the same, and the intensity is increased as this same difference is increased.

The addition of iron compounds increases the intensity of coloration, but stable glasses of normal intensity can be produced without added iron.

The addition of small proportions of fluorides is shown to give a very great increase in color intensity. This phenomenon apparently has not been observed or reported previously.

4. The Additivity of Some Practical Glass Properties. *By F. R. Matson and W. A. Weyl, Pennsylvania State College, State College, Pa.*

Several papers have been published in recent years on the additivity of certain glass properties. However, practical experience and the patent literature show that marked improvements in some properties can be obtained by the use of mixtures of alkalis or of alkaline earths. Those properties that are due to the almost instantaneous response of glass to external forces that do not change the mutual positions of its constituents can be considered additive (index of refraction, dispersion and molar refraction). In another group of properties of great practical importance—viscosity, stable fields of glass formation, density, dielectric constant, power loss and electrical conductivity—it is not possible to predict the changes that may occur when a mixture of two glass-forming oxides is used if the values for only the end members are known. These properties involve either a temporary disturbance of the glass structure or the nature of the packing of the constituents.

Tuesday Morning, April 25, 1950
9:30 A.M.-12:30 P.M.
Salle Moderne

5. Dielectric Properties of Glasses Containing Heavy Metal Ions. *By R. R. Shively and W. A. Weyl, Pennsylvania State College, State College, Pa.*

It is well established that alkali ions strongly increase dielectric loss of glasses. The contribution of the alkali ions to dielectric loss can be decreased by the use of a combination of alkalis or by the substitution of a more polarizable divalent action for a less polarizable one in the glass structure. The substitution of cupric ion for magnesium ion was found to be very effective in decreasing the dielectric loss of silicate glasses.

6. Corrosion Resistance of Pure Alumina as a Glass Refractory. *By Frank Day, Corning Glass Works, Corning, N. Y.*

Laboratory corrosion tests show that a very pure nonporous single crystal of alumina corrodes more rapidly in contact with lime glass at elevated temperatures than do some commercially available refractory compositions.

7. A Method for the Density of Glass in the Working Range. *By Donald H. Dryer and S. R. Scholes, Department of Glass Technology, New York State College of Ceramics, Alfred, N. Y.*

The glass specimen is contained in a platinum crucible and suspended in a bath consisting of the eutectic mixture of $Li_2SO_4K_2SO_4$. The density of the bath over the temperature range 600° to 900°C. is determined by suspending in it a plummet of fused silica. The buoyancy of the glass in the molten salts becomes a means of estimating its density.

8. The Increased Acid Resistance of Flint Glasses Containing Zr, Ti, Ta, or Nb (Cb). *By M. Aposhian and Norbert Kreidl, Bausch & Lomb Optical Co., Rochester, N. Y.*

The development of a ¼ wave length film in acidic media is taken as a measure of acid resistance of flint glasses improved by the introduction of relatively small percentages of ZrO_2, TiO_2, Ta_2O_5 (or Nb_2O_5). The time for the formation of this film may be increased by one or more orders of magnitude by less than 10% of these oxides in a simple K_2O-PbO-SiO_2, base glass selected for this investigation.

Tuesday Afternoon, April 25, 1950
2:00-5:00 P.M.
Salle Moderne

9. Color Variations in Glasses Containing Iron: Alkali Calcium Silicates. *By G. F. Brewster and Norbert Kreidl, Bausch & Lomb Optical Co., Rochester, N. Y.*

Quantitative data on the variation of the ultraviolet, visible and infrared absorption as well as the chromaticity as a function of concentration, reduction-oxidation equilibrium and composition are presented for substituted alkali calcium silicate glasses containing iron.

10. Color Variations in Glasses Containing Iron; Other Base Glasses. *By G. F. Brewster and Norbert Kreidl, Bausch & Lomb Optical Co., Rochester, N. Y.*

Quantitative data on the variation of the ultraviolet, visible and infrared absorption as well as the chromaticity as a function of composition are given for less conventional glasses containing iron, such as barium, lead, titanium silicates, borosilicates modified by Al, Zn, and F, aluminates and phosphates. Some of these base glasses are used in heat absorbing and neutral filters.

11. Single Number Tolerances for Colored Glass Specifications. *By Norbert Kreidl and T. G. Pett, Bausch & Lomb Optical Co., Rochester, N. Y.*

Chromaticity data of glasses were measured by the Hunter Color Difference Meter and converted to single numbers representing distances in color space between each glass and a glass in the center of an appropriate specification. This simple evaluation gave as good a correlation to visual specification as the more complicated evaluation of spectrophotometric data. Regardless of whether the color deviation was in transmission, hue or saturation, the uncertainty of the line of rejection was only ±0.05 where a distance of 1.5 Hunter units described a commercial tolerance.

12. The Influence of Iron Additions on the Ferrous-Ferric Equilibrium in Glass. *By W. H. Beazell, M. Humenik and H. E. Simpson, New York State College of Ceramics, Alfred, N. Y.*

A study was made of the effect of increasing iron additions on the ferrous-ferric equilibrium in glass, and the effect of different sources of iron on the equilibrium. It was found that the ferric-ferrous ratio was constant as expressed by the equation:

$$\frac{(Fe_2O_3)^3}{(FeO)^4} = K$$

It also appeared that the source of iron had no effect on the equilibrium. Titration, using ceric sulfate and orthophenanthrolein indicator, was the method of analysis.

Wednesday Morning, April 26, 1950
9:30 A.M.-12:30 P.M.
Salle Moderne

13. The Thermal-Radiation Characteristics of Some Glasses. *By Howard O. McMahon, Arthur D. Little, Inc., Cambridge, Mass.*

The Emissivity, Reflectivity and Transmissivity have been studied for a number of glasses throughout the wave-length region 2.2 to 15μ and temperature range of 500° to 1500°F.

In general it is found that although the spectral emissivity varies considerably with wave length throughout the opaque portion of the spectrum, the over-all emission spectrum is almost completely independent of temperature.

The most interesting feature of the emission spectrum of all silicate structures studied is the metallic reflection band at approximately 9.5ν. Some theoretical conclusions may be drawn regarding the location and shape of this band.

14. The Measurement of the Temperatures of Hot Glass by Radiation. *By W. T. Gray, Leeds & Northrup Co., Philadelphia, Pa.*

The basic principles of temperature measurement by radiation are reviewed, particularly with regard to difficulties commonly encountered and the errors which they cause in the measurement of temperature. The radiating properties of glass are considered in the light of the foregoing principles. A method is discussed for measuring the temperature of hot glass by utilizing the infrared spectrum in the region between 4 and 8ν where glass radiates essentially as a black body.

16. Increases in the Tensile Strength of Glass Caused by Extended Water Immersion Treatment. *By G. F. Stockdale and F. V. Tooley, University of Illinois, Urbana, Ill.*

An investigation was undertaken to determine quantitatively the effect of extended water immersion on the tensile strength of three commercial glasses. Test specimens were prepared by drawing soda-lime, borosilicate and lead glass rods down to 0.012 inch in diameter. Large numbers of these carefully prepared specimens were immersed for varying times in distilled water maintained at 90°C. Equal numbers of identical control specimens were kept in a desiccator during the immersion periods to give comparative strength results between the treated and untreated specimens. This comparative technique held to a minimum the effect of many of the errors frequently resulting from specimen preparation. Significant strength increases were found for immersion periods as short as five minutes while increases greater than 60 per cent were found for the borosilicate glass after long time treatment. Curves expressing the strength increase as a function of immersion time for the three glasses are given. The results are discussed with reference to the surface flaw theory of glass strength.

Wednesday Afternoon, April 26, 1950
2:00-5:00 P.M.
Salle Moderne

17. A Study of the Effect of Lubricants upon the Adherence of Molten Glass to Heated Metals. *By W. C. Dowling, H. V. Fairbanks and W. A. Koehler, West Virginia University, Morgantown, W. Va.*

An improved kinetic test was devised by means of which the adherence of molten glass to metal may be evaluated. The results were expressed as the highest metal temperature at which the molten glass beads do not adhere. The variables of the test investigated were: temperature of molten bead, height of fall of the molten bead, and slope and surface roughness of metal sample. The cumulative effect of the variables on the precision of measurement of the adherence temperature was found to be ±33°F.

Several types of glass mold lubricant were investigated as to their effects on the adherence temperature and to their persistence on heated metal surfaces. Several silicone lubricants were found to have high critical adherence temperatures while the graphitized oil base lubricant gave the best persistence.

18. Recent Trends in Supplies of Raw Materials for the Glass Industry. *By R. J. Anderson, Battelle Memorial Institute, Columbus, Ohio.*

Like all industries requiring a large volume of raw materials, the glass industry has been affected by recent developments in the supplies of raw materials. Adjustments following World War II are now virtually completed, and something approximating a normal supply situation can now be studied. The principal factors affecting the supply of the bulk materials: silica, lime and soda, will be reviewed. New sources of supplies of some of the small volume, yet highly important materials, are described. Indications of future trends will be included in the description of each commodity.

19. Business Session.

20. The Effect of Na_2O-K_2O Ratio on the Chemical Durability of a Soda-Lime-Silica Glass. *By Sudhir Sen and F. V. Tooley, University of Illinois, Urbana, Ill.*

The chemical durability (water) of mixed alkali (soda and potash) glasses was determined by estimating the Sodium and Potassium ions extracted instead of the indirect way of evaluating it from the alkalinity of the extracts. In a glass of composition—alkali, 18%; SiO_2, 72%; CaO, 10%—the number of mols of total alkali extracted decreases with decrease in Na_2O content until at a ratio of about K_2O/Na_2O (by wt.) 4.14/1, it reaches a minimum. This minimum is not well marked; with further increase of K_2O only a slight increase in the total mols of $K_2O + Na_2O$ extracted is observed. When mols of Na_2O are in excess, the sodium exerts the controlling influence on the attack; when mols of K_2O are in excess, the potassium is the controlling factor.

21. Physical Properties and Constitution of Soda—Lime Germania Glasses. *By N. M. Parikh and H. E. Simpson, New York State College of Ceramics, Alfred, N. Y.*

The physical properties of some Na_2O-CaO-GeO_2 and Na_2O-CaO-SiO_2 glasses were compared. The glasses were compounded on a molecular basis and the RO_2 was held constant. Physical properties were determined: softening point, viscosity, strain point, annealing point, thermal expansion, density and refractive index. The possible constitution of these glasses is discussed on the basis of their physical properties.

PHYSICAL CHEMISTRY PROGRAM

Tuesday Morning, April 25, 1950
9:30 A.M.-12:30 P.M.
Penn Top North

1. A Portion of the System MgO-1_2O_3-2CaO · SiO_2. *By A. T. Prince, Bureau of Mines, Ottawa, Canada.*

The system MgO-Al_2O_3-2CaO · SiO_2 comprises a plane through the tetrahedron CaO-MgO-Al_2O_3-SiO_2. Quenching experiments were made on compositions having an alumina content below the line joining 2CaO · Al_2O_3 · SiO_2 (gehlenite) and MgO · Al_2O_3 (spinel), and having liquidus temperatures below 1600°C.

Compositions in this system are of significance in an investigation of the constitution of basic refractory clinkers made from Canadian dolomitic magnesites.

2. Invariant Points in the Quaternary System CaO-MgO-Al_2O_3-SiO_2. *By E. F. Osborn, R. C. DeVries and D. B. Tait, The Pennsylvania State College, State College, Pa.*

Phase equilibrium data are presented for the following systems, each of which is a part of the quarternary system CaO-MgO-Al_2O_3-SiO_2:diopside-forsterite-anorthite, anorthite-periclase-forsterite, anorthite-periclase-corundum, anorthite-gehlenite-spinel, and anorthite-forsterite-spinel. The data obtained for these five planes lying in the CaO-MgO-Al_2O_3-SiO_2 tetrahedron, along with data obtained for miscellaneous quaternary mixtures and data previously published, are used as a basis for estimating the composition and temperature of quaternary liquidus invariant points. Leaving out of consideration phases whose relations are not well established (e.g., sapphirine and CaO · 6Al_2O_3), it is shown that 27 quaternary liquidus invariant points exist. The tetrahedron is divided into five composition volumes for a discussion of the position and interrelations of these points.

Tuesday Afternoon, April 25, 1950
2:00 P.M.-5:00 P.M.
Penn Top North

7. Flame Fusion Synthesis of Silicate Structural Types. *By W. H. Bauer and I. Gordon, Rutgers University, New Brunswick, N. J.*

The Verneuil or flame fusion technique has been applied to the synthesis of the various silicate structural types. Using the classification of silicates, based on the linkage of the silicon tetrahedra, several anhydrous minerals from each of the five classes were investigated. Successful syntheses have been obtained in all classes but the pyrosilicate. In addition to X-ray and petrographic data for each of the synthesized crystals, a description of the equipment, types of burners and feed preparation is presented.

The advantages and difficulties of this method are discussed. The results indicated that for many anhydrous silicates the flame fusion process can be a valuable research technique.

8. The Atomic Structure and Chemical Reactions of the Silica Surface. *By Tormod Forland, P. A. Marshall, Jr. and W. A. Weyl, Pennsylvania State College, State College, Pa.*

The atomic structure of all natural and artificial silicates, including glasses and colloids, are governed by three basic principles: the tetravalency of silicon in the solid state, the fourfold coordination of silicon in respect to oxygen ions and the strong repulsion forces acting between two silicon ions in neighboring SiO_4 tetrahedra preventing these units from sharing edges and faces. It can be demonstrated that a silica surface obtained by the fracture of a crystal or glass or by the dehydration of silica gel must violate at least one of these three principles.

In order to decrease the surface-free energy, the extreme outer layer of silica has to be formed by the oxygen ions because they are by far the most polarizable constituents of the system. The resulting electrical double layer is responsible for some of the colloidal properties of silica.

By the same consideration the dehydration of silica gel does not limit itself to the formation of neutral water molecules alone, but is accompanied by the liberation of protons. This phenomenon which is greatly affected by impurities explains the action of the silica catalysts used in oil cracking. In aqueous solutions, the probability of protons being released is a function of the pH of the medium. The mechanism of the glass electrode explains itself on this basis.

Another phenomenon accompanying the formation of a free silica surface is the cleaving of O_2 molecules leading to atomic oxygen. As a result dehydration of a silica gel at slightly elevated temperatures gives positive tests with indicators used for detecting ozone. The role of impurities played in these unusual chemical reactions is exemplified by cobaltous ions and chromic ions adsorbed at silica gel which change into Co^{3+} and Cr^{6+} at elevated temperatures.

Wednesday Forenoon, April 26, 1950
9:30 A.M.-12:30 P.M.
Penn Top North

12. Ionic Rearrangements in Glasses in the Annealing Range. *By M. D. Beals, National Lead Co., South Amboy, N. J., and W. A. Weyl, Pennsylvania State College, State College, Pa.*

The formation of mixed crystals between NaCl and Kcl in the high-temperature region (500°C.) and the exsolution of this binary system in the low-temperature region (60°C.) has been studied by means of X-ray diffraction patterns and thermal analysis. This system is used as a model for the ionic rearrangements taking place in glasses during annealing.

Glasses of simple but widely varied compositions were subjected to different heat treatments. Their heating curves showed exothermic and endothermic effects analogous to those observed in the solid solutions of the alkali halides. This method is suggested as a tool for studying phenomena related to the "compacting" of glasses during annealing.

Wednesday Afternoon, April 26, 1950
2:00 P.M.-5:00 P.M.
Penn Top North

15. The System Beryllia-Alumina-Titania: 1, Phase Relations in the Subordinate Binary Systems. *By S. M. Lang and L. H. Maxwell, National Bureau of Standards, Washington, D. C.*

Investigations of the phase relations in the binary systems beryllia-alumina, alumina-titania and, especially, beryllia-titania, have shown that in the published equilibrium diagrams of each of these systems there are one or more of the equilibrium conditions (or states) which are not compatible with more recently obtained data. Revised diagrams are presented for each of these systems.

MATERIALS AND EQUIPMENT DIVISION PROGRAM

Monday Afternoon, April 24, 1950
2:00-5:00 P.M.
Parlors B & C

3. The Application of Hydraulic Actuation to the Ceramic Industry. *By Edward M. Greer, Greer Hydraulics, Inc., Brooklyn, N. Y.*

A discussion of the principles of hydraulic actuation and its application to the ceramic industry is given. A U. S. Navy film on airplane hydraulic system applications will be shown.

Tuesday Afternoon, April 25, 1950
2:00-5:00 P.M.
Parlors B & C

11. Transportation Is Part of Every Production Line. *By Hobart H. Young, Pennsylvania Railroad, Philadelphia, Pa.*

Reviews the essentials of satisfactory transportation, including factory handling and distribution through to retailer. Importance of adequately protective packaging and secure loading to withstand the common damage hazards of transportation. What the Porcelain Enamel Institute's "National Safe Transit Program" is, what it has done and can do for enameled products. Proper destination inspections, useful reporting of damage and analysis of such reports by carriers and by manufacturers. The miracle of materials handling from the back-breaking methods of manual handling a half-century ago to the push-button mechanical equipment of today. Effect upon goodwill and sales schedules of frequent damage. Improvements in railroad plant, freight cars and motive power providing smoother riding track and cars and better freight service; training of supervisors and rail personnel in general to promote intelligent and careful handling of shipments.

Wednesday Morning, April 26, 1950
9:00 A.M.-12:00 M.
Joint Session with White Wares Division
Parlors B & C

15. Design-Relationship to Production Methods. *By Norman Jae, Ram, Inc., Columbus, Ohio.*

A brief history of design-relationship to production methods from ancient times to present day. Discussion on various problems involved in manufacturing shapes of varying symmetry. Mechanization—keeping pace with the trends of time.

REFRACTORIES DIVISION PROGRAM

Tuesday Morning, April 25, 1950
9:00 A.M.-12:00 M.
Georgian Room

6. An Automatic Apparatus for Testing Super-refractories Under Tensile and Compressive Loads at High Temperatures. *By J. A. Scarlett and J. A. Robertson, Westvaco Chemical Div., Food Machinery and Chemical Corp., Newark, Calif.*

Construction and operating details are given for an apparatus used for testing small refractory specimens under tensile or compressive loads up to 2200°C. An electrical resistance, graphite tube furnace can be made to heat at a uniform rate of 0-1000°C/-hr. and to shut off at a predetermined specimen temperature or deformation. Temperature is measured by a radiation pyrometer and controlled by a duration-adjusting, impulse-type controller. Deformation is measured by means of a micrometer dial gauge and transmitted

(*Continued on page* 221)

MECHANIZATION OF THE GLASS INDUSTRY

By GEORGE E. HOWARD
Butler, Pa.

PART III—GLASS CONTAINERS

The evolution of the container branch of the glass industry has much in common with that of window glass in that it required the skill of delicate craftsmanship during the period when glass container manufacture was a manual operation.

In common with window glass manufacture, it likewise differed from plate glass manufacture in that the steps in its progress from manual operation to mechanization were more numerous, and the technical problems to be solved tended to divert attention from the basic law of "material movement", and to focus it more upon the more superficial but less economically important factors of gadgetry. Unlike either plate glass or window glass, containers differ radically. Sheet glass is a bulk product and its ultimate use is usually to cover an opening to admit light or permit vision. It was mainly a matter of cutting to size of the opening. Bending from a flat to a curve or use as a mirror are exceptions. Its use as shelves or other structures is of lesser importance. Sheet glass is a capital goods article. Containers, with some minor exceptions, are consumer articles.

They are secondary, not primary articles, packages to hold contents such as beer, pills, milk, foods or medicine, the market for which depends on the necessities or fancies of the consuming public. There is an almost infinite variety of sizes, weight, shape and color. They can not ordinarily be made and stored at the factory or central warehouse in any considerable amount like sheet glass in bulk. This greatly complicates the size and distribution of orders, determines to some considerable extent the location of plants regardless of population density.

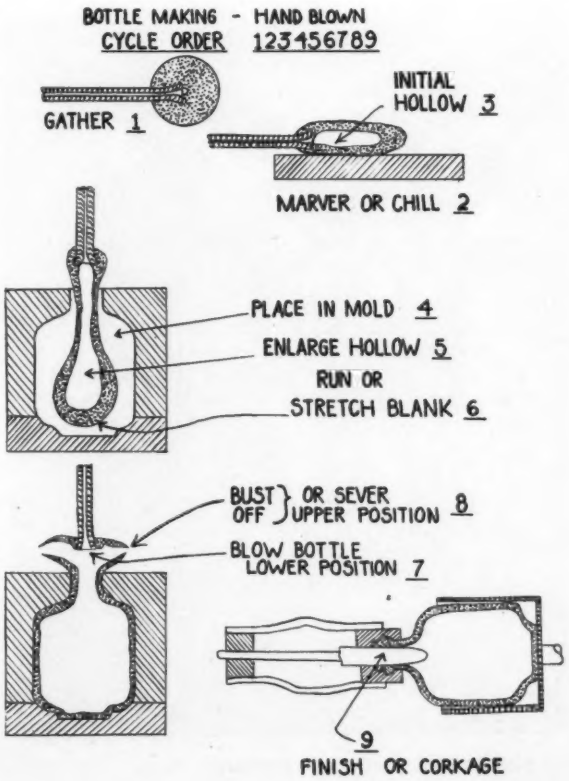
As an example, a brewery or distilling center would normally attract nearby production of liquor bottles. Likewise, a large fruit or vegetable raising area would normally encourage a packing and preserving center and a source of production of glass containers. The Heinz plant at Pittsburgh had a bottle plant within railroad switching distance of its main plant. Before prohibition, Milwaukee had four large bottle plants making mostly beers. Other factors, such as availability to fuel and raw materials, were important.

This summary is mentioned for the reason that it had a direct influence on the progress of mechanization. The basic object, like that of the two preceding divisions, was to effect the most "efficient movement of materials", but with this difference—the movement was mainly from the batch material to a bottle delivered at the filling point rather than to the ultimate user.

In some cases, such as milk bottles, the dairies were scattered in a city and a glass plant located there could deliver bottles in cases and thus avoid the expensive packing for railroad shipment, save on salesmen's expenses and other items. In extreme cases, packing and freight has exceeded the cost of making the bottle in the factory. Thus a small plant with a hand blown or semi-automatic process could profitably compete with a large automatic plant which had to pack and ship its ware at a distance. Another important factor was the size of orders. At one time milk bottle orders, in spite of a few orders running up to a hundred thousand gross, only averaged twelve gross per order.

Standardization and the growth of large dairies has changed all this. Formerly bottles were often made with the name of the dairy blown into the bottle for advertising purposes. This necessitated expensive molds useful for only one customer. So unless orders were large or sure of repetition, the mold expense alone might exceed the remaining cost of the bottle. Inserted panels with the bottler's name and recently the practice of using applied color labels burned onto the bottle in a decorating lehr have cheapened the former practice and added color as an additional attraction to an otherwise standard bottle.

If we follow all these factors through, we can readily see the law of material movement expressed in dollar cost, but it is obvious that to trace the evolution of container mechanization and to take into consideration the almost limitless factors involved would be impossible within the space limits of a presentation such as this.



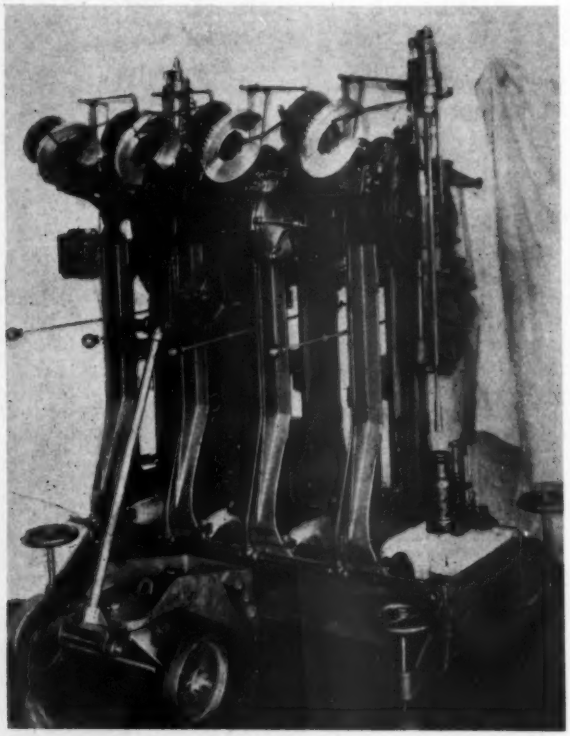
Blowing bottles by the hand process.

Hand method of finishing bottles.

We will therefore confine our story to mechanization within the factory. This localization is generally the most important, anyway.

The hand blown bottle process is familiar to most laymen and especially to our readers. Originally, nothing but a blowpipe and a skilled craftsman were used. The blower gathered a portion of very viscous glass on the end of his blowpipe, and by manual manipulation managed to form a neck and body to the bottle. He even made the finish by wrapping a strand of molten glass around the top of the neck after breaking the neck off from the portion attached to the blowpipe.

The size of the opening, or corkage, was varied and the bottle sealed by corks varying in size to suit the diameter of the opening. Bottles varied in size and content as no molds were used. But it was surprising how uniform bottles could be made by a skilled blower. While they used a clay mold, some large bottles, such as 15-gallon carboys for holding acid, were until recently made with the corkage finished by a strand of glass. The stoppers were loose with sufficient tolerance to allow for the variation in size of the opening. Stoppers made of clay were used instead of corks and the corking was more a matter of covering than sealing.



Corning semi-automatic bulb machine.

An important step was the use of the marver, a plate usually of iron on which the blower rolled his gather to cool it to a higher degree of viscosity, at the same time puffing air into the interior of the gather to form an elongated bubble. This marvering caused the gather to become uniform in temperature and viscosity, not only on the surface, but more or less through the entire mass of the bubble. It was then blown after the blow mold was closed about the bubble. This was a delicate operation, especially in such bottles as ammonia bottles with thin necks and large bodies. When the bubble was blown against the interior of the mold and held long enough to set, the blower gave a hard puff and burst the bubble between the end of the blowpipe and the mold, leaving a thin ragged edge.

Next the bottle, consisting of a body and a neck, was taken from the mold and the body held in an open ended can or a clamp attached to a round rod. A boy would insert the cold ragged end of the neck into the hole of a heating furnace, called the glory hole, then transfer the can or clamp holding the bottle body to a finisher who completed the finish and corkage by a rolling process. His seat was called the chair, and this operation was much less strenuous than gathering, marvering or blowing, and the same craftsmen performed the various operations alternately. Three gatherers and two boys usually made a shop.

The operation is plainly shown in photographs, and should make this process clear. The gathering, marvering and blowing were delicate operations, but the finishing was not nearly so strenuous or delicate. The finishing tool determined the size and roundness of the corkage, and the outside finish was determined by the interior contour of the tongs. This was really the start of mechanization as almost anyone could learn to do it with a little practice. The union craftsmen did it

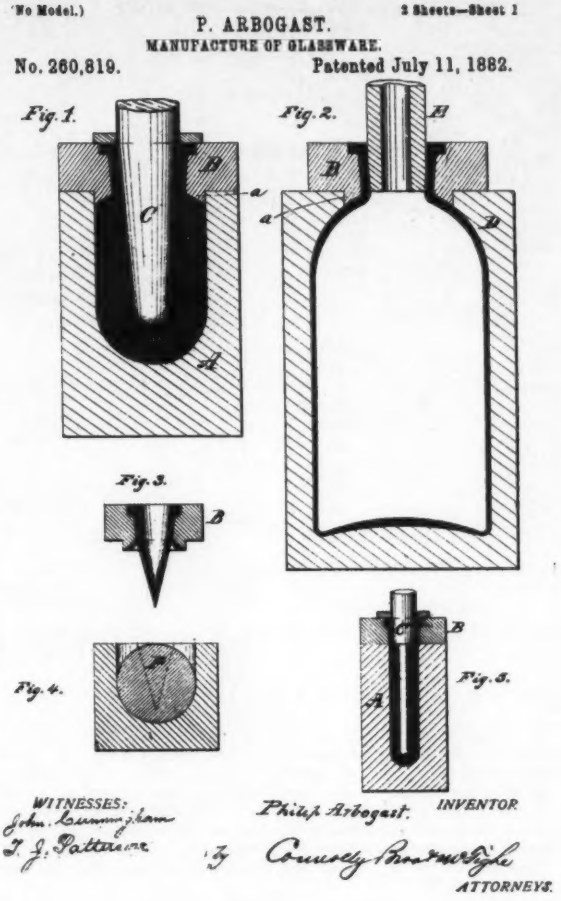
What I claim as my invention is

The described improvement in the manufacture of glassware, consisting in pressing the mouth or neck to finished form with a dependent mass of glass, then withdrawing the plunger, then removing the article from the press-mold, and finally inserting it in a separate mold and blowing to form the body, substantially as described.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in presence of two witnesses.

PHILIP ARBOGAST.

Witnesses:
THOS. J. McTIGHE,
A. V. D. WATTERSON.



partly to get the respite from the more arduous blowing and partly, probably mostly, to maintain more men for the union. It was natural that this step was the first one in which to attempt mechanization.

A finishing machine was invented and it worked, eliminating a boy and replacing a craftsman with cheaper non-union labor. While the finishing machine would work, it required the blow-off to be uniform. The hand finisher could manipulate his hand finishing tool to take care of poor blow-offs while the machine could not, as it was devoid of the senses of sight and touch. Strange as it would seem, the union craftsmen did not refuse to work with the mechanical finisher. They probably would have if it had become necessary, if for no other reason than the legitimate one which deprived the blower of his respite from blowing by taking his turn at finishing.

He used a more crafty way to kill the machine. Whenever he worked with the mechanical finisher, he somehow managed to make more poor blow-offs; so many in fact, that the mechanical finisher lost too many bottles and the loss exceeded any possible savings. Thus it was promptly abandoned without too much recrimination by owners.

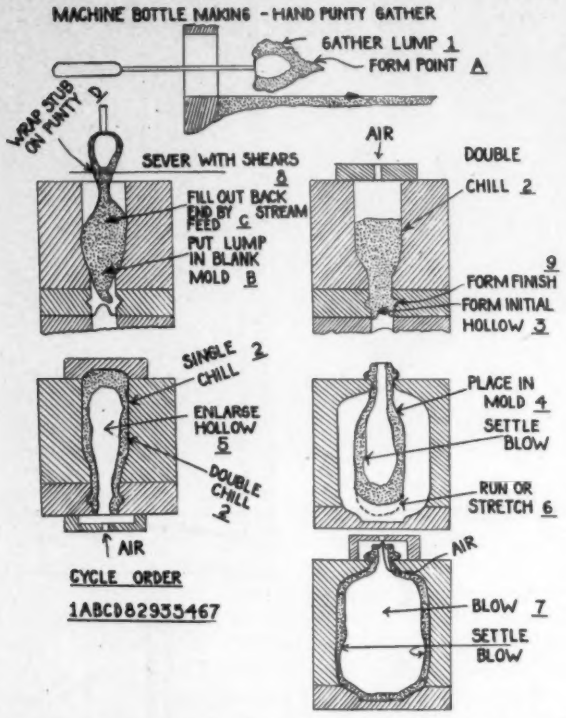
Inasmuch as the finishing operation required not too much skill, and the gathering, marvering and blowing a high degree of skill, to my knowledge, no commercial reproduction of the manual operations by mechanical means ever reached a commercial stage in bottle making. There was an exception, however, in electric bulb manufacture. The Corning company developed a machine, shown in the photograph, that marvered and blew the bulb after a craftsman had gathered the glass on the end of the blowpipe, and inserted the blowpipe in a machine. This was commercially successful, and made a considerable saving in bulb manufacture. The electric bulb did not have a finish.

About this period, a new concept for bottle making by a great genius was invented. That inventor was Philip Arbogast of Pittsburgh. In the 1870's he experimented with a machine with this new concept. He departed entirely from the more obvious attempts to solve the problem of mechanization by substituting or imitating the movements of the blower. A patent was issued in 1882, the patent drawings and his single but broad claim being shown here. Lacking sufficient financial backing or even lukewarm interest by bottle manufacturers, he was unable to bring his invention to commercial success. Nevertheless, his disclosure provided the key to bottle mechanization.

Most glassmen never knew of him or his work, and he received no pecuniary reward, nor recognition commensurate with the importance of his invention; notwithstanding that not even a start or first step in mechanization could be made without it. Every modern machine would have failed without it. The patent drawings and claim shown validate these statements.

His was no vague disclosure by a dreamer, but a practical working drawing and description shown in meticulous detail. A brief sketch of his efforts certainly deserves a short space in this presentation. His funds became so depleted that he tried to sell his invention to get enough money to live on, but without success. He was a man of sterling character with faith in his vision. A Pittsburgh manufacturer, his good friend and admirer, bought the patent for $250, not that he wanted it or appreciated its value. It was the only way to help his friend who was too proud to accept charity.

It is a sad commentary on the intelligence of the men in the glass industry that his invention never reached commercial success until the expiration of the patent near the close of the last century. So completely did he deviate from the conventional process that the finish, so-called because it was the last operation in hand blown ware, was made the first in his system. Ironically, that part of the bottle is still called the "finish". Here, at a single stroke, was a complete revolutionary invention that disclosed all the essentials of glass bottle blowing mechanization. The complete picture in its broad aspects is something like this: Arbo-



The sketch and notations shown explain the hand gather: *Attention is drawn to the settle blow which occurs both in the blank and in the finished ware. This is caused by inability to fill the molds sufficiently so that a portion made by enlarging the hollow is chilled a lesser time and so that in blowing the portion with the single chill, it tends to become relatively thinner and causes a wave at the portion between the glass having the double chill and that having the single chill.*

gast made a complete disclosure of mechanization in bottle making, not as some vague visionary statement of the problem, but as a practical detailed working drawing which has never essentially changed.

Even the proportions shown were accurate. During the following two decades, this invention was kicked around, the inventor given no encouragement or recognition, and no adequate financial reward. During the following 50 years came the cost for hundreds of patents by scores of inventors, the expenditure of millions of dollars for attorney and court fees, other millions for profits and royalties, and accordance of world-wide recognition for the successful engineers and inventors and organizers of great glass industrial empires who were devoted to complete the last and final step in automatic mechanization.

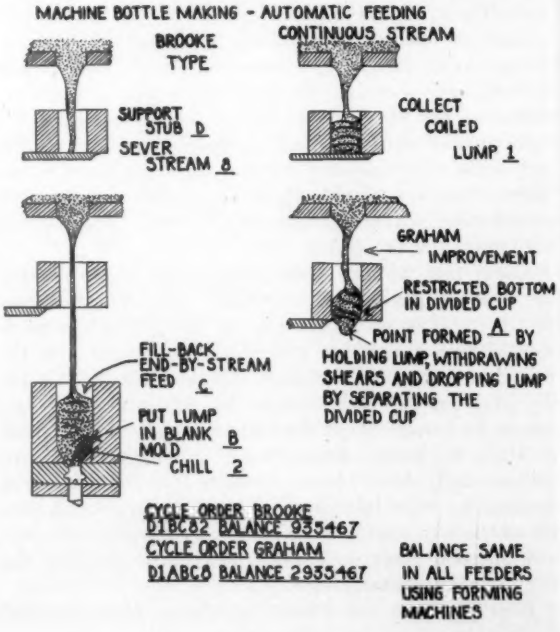
It is no disparagement to the brilliant engineers and inventors of mechanical means for merely filling the blank mold to note that, compared to the brilliant, pioneering invention and practical disclosure of Arbogast, their light should shine as dimly as a candle in the full blaze of sunlight.

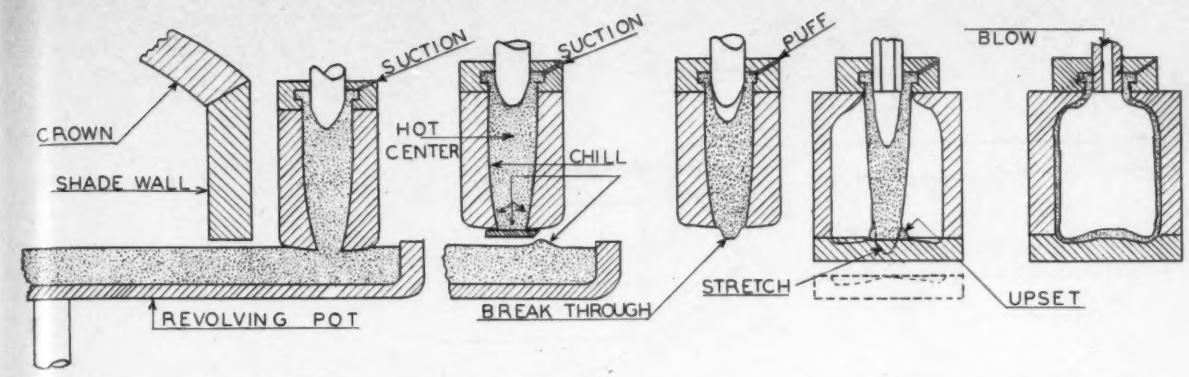
In the first place, the invention of the blank was utterly without precedent, while the feeding of glass to a press mold by punty was an ancient art in universal use for years. Likewise, the development of the various gadgets for supporting, opening, closing, reversing and transferring the molds to receiving position was more kinematics and engineering than invention.

The essence of the Arbogast invention was mainly concerned with a new cycle in working the glass, specifically the addition of a blank, or blowing a bottle in two stages instead of one. This had no precedent. On the other hand, gathering and mold filling with molten glass manually was a definite lead or precedent for the gradual development of a mechanical system for performing this operation.

Mechanical flowing of glass was not a new concept. Basically, it was only the development of a different tool, one to be machine guided instead of hand guided. There were many leads or precedents, and among them was the simple device of pouring very hot glass over a lip or through an opening. This was a well-known way to provide an overflow for keeping the glass level in tanks at a desired predetermined level, for draining surface scum and for various other purposes. In filling the blank mold the flowing stream had to be cut into individual quantities each of proper weight for the particular article needed. For this, cutting shears used in punty gathering were already in use, and operating them by a timer was so obvious that no basic invention was involved. As extremely hot glass was necessary, owing to the extraction of heat by two molds (blank and blow molds), some mechanical scheme for retarding the glass stream was necessary to permit time for the filled mold to be replaced by the next succeeding empty mold.

The thin stream flowed so rapidly and attenuated to such a small diameter that it had to be held back by cooled shears or cups. If the shears or cups were hot, the glass stuck to them and smeared up the operation. If they were cold enough to prevent smearing, there developed a cold surface or spot where it contacted with shear or retaining cup, and, when dropped into the mold followed by the hot glass or the stream, it had insufficient time for reheating or temperature equalization to permit proper distribution of the glass when expanded in the blow mold. Space does not permit the inclusion by drawings and description of all the numer-


MACHINE BOTTLE MAKING - AUTOMATIC FEEDING
BROOKE TYPE
CONTINUOUS STREAM
SUPPORT STUB D
SEVER STREAM 8
COLLECT COILED LUMP 1
GRAHAM IMPROVEMENT
RESTRICTED BOTTOM IN DIVIDED CUP
POINT FORMED A BY HOLDING LUMP, WITHDRAWING SHEARS AND DROPPING LUMP BY SEPARATING THE DIVIDED CUP
FILL-BACK END-BY-STREAM FEED C
PUT LUMP IN BLANK MOLD B
CHILL 2
CYCLE ORDER BROOKE D1BC82 BALANCE 935467
CYCLE ORDER GRAHAM D1ABC8 BALANCE 2935467
BALANCE SAME IN ALL FEEDERS USING FORMING MACHINES



These sketches show schematically five stages in the operation of the Owens Suction System: ***A blank mold is dipped into the hot glass contained in a revolving tank which is covered by a reverberatory furnace. The shade wall exposes a segment of the revolving pot. Suction is applied and the blank formed by the glass is forced upwardly by the pressure difference created by the suction.***

The mold is then lifted and a shear blade cuts off the stream and forms the bottom of the blank mold. Glass is chilled on sides and bottom with a thin hard skin and hot center. Also, a chilled lump is lifted on the surface of the revolving tank which is reheated by passing beneath the reverberatory furnace.

The suction is then replaced by controlled pressure or puff. The hot center glass breaking through the chilled glass formed on the shear which is previously removed.

A blank mold is then parted and replaced with a blow mold. The thin chilled skin is partially reheated and the glass stretches to positions shown by dotted lines. The bottom plate is in position shown by dotted lines, which is then raised to form the permanent bottom, thereby upsetting the hot glass around the chilled bottom of the gather.

Finally, pressure is applied to the interior of blank and the bottle completed. Due to the chill from the shears, the bottom remains thicker. Shoulders and lower corners of bottle become thinner.

ous devices used to make a successful job of this hot glass gravity flow stream feed.

The nearest to commercial success was the invention of Homer Brooke which was entirely impractical as shown by his patent drawings and description, but when modified by inventions of Charles Blue and others, was finally developed by the Hazel-Atlas Glass Company into an ingenious machine and process good enough to make certain types of containers that met the standards of the time. The sketches show diagrammatically certain types of operation of stream feeding bottle machines. Finally, the stream feed was made successful by the invention of Michael Owens using the glass forming cycle of Arbogast by adding his own blank feeding system.

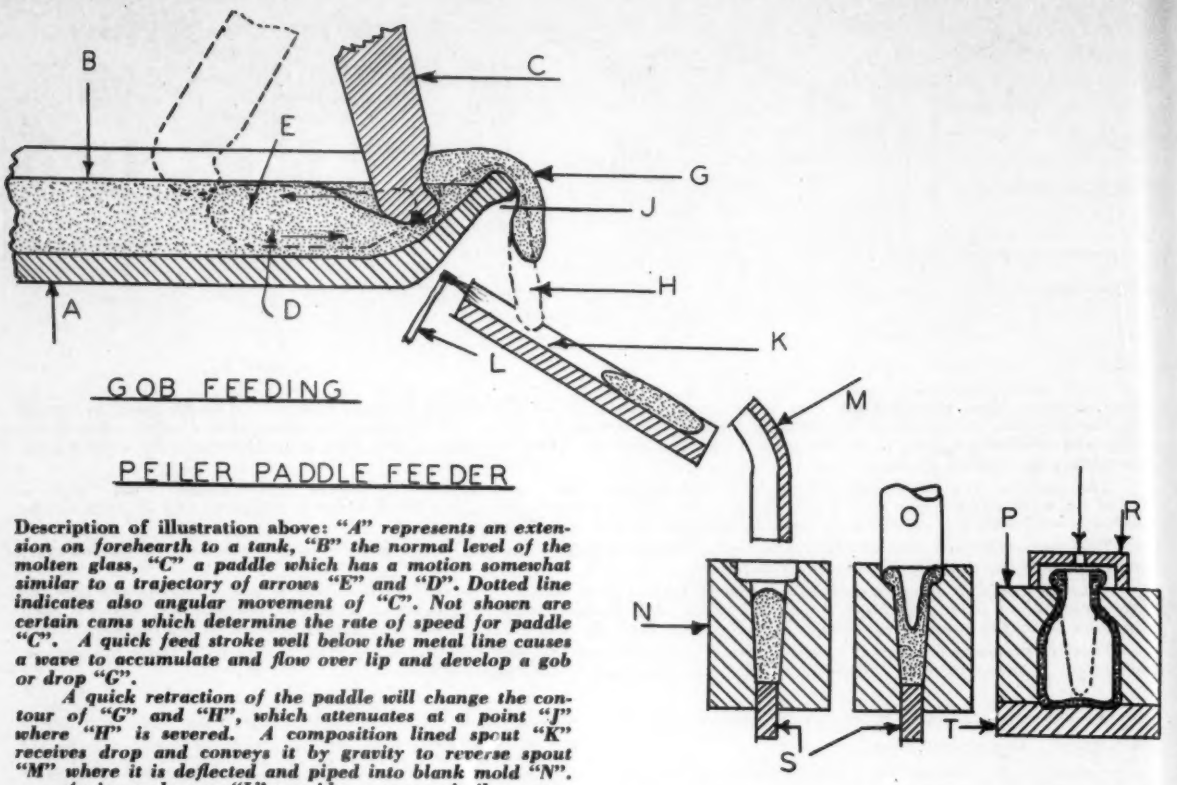
Like Arbogast, Owens was a practical glass worker and an inventor with keen vision. With these qualities, was added an ample fund of good horse sense. He realized that a gather of hot gravity streaming, dribbling glass and a chilled portion could not mix in an iron mold and then reheat itself uniformly enough to make a good bottle, certainly not the enormous number of bottle styles demanded by the trade. He knew that thin hot glass flowed too fast by gravity to properly fill blank molds. He knew that the same thin hot glass could be made to flow uphill against gravity by suction and proceeded to do just that. He sucked the glass up through the bottom of the blank mold into the neck mold and around the corkage plunger from the surface of the hot glass in the tank or other receptacle.

To do this, the heavy heat absorbing mold had to be plunged into the glass to enable the pressure of the atmosphere to force the glass upwardly into the mold which was under high sub-atmospheric pressure, or vacuum as we usually term it. This permitted the glass stream to retain a large diameter and a rapid filling of the mold. The mold was then lifted and the connecting stream between the glass in the mold opening severed by a shear which formed the bottom for the blank mold. After the blank mold was removed, the glass blank held by the neck ring was enclosed by the blow mold and the bottle blown in the conventional manner. The Owens bottle forming cycle was strictly a stream feed gather, the very hot thin glass flowing up hill instead of down hill by gravity.

Owens Suction Stream Feed vs Gob Feed

Until well into the second decade of this century, the economic situation in the glass container industry was about as follows: although the basis for mechanization

Making bottles by absolutely automatic processes.



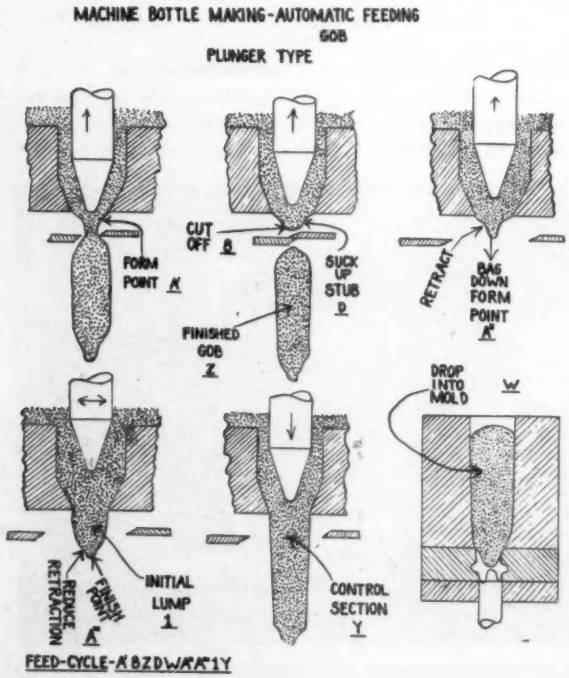
GOB FEEDING

PEILER PADDLE FEEDER

Description of illustration above: *"A" represents an extension on forehearth to a tank, "B" the normal level of the molten glass, "C" a paddle which has a motion somewhat similar to a trajectory of arrows "E" and "D". Dotted line indicates also angular movement of "C". Not shown are certain cams which determine the rate of speed for paddle "C". A quick feed stroke well below the metal line causes a wave to accumulate and flow over lip and develop a gob or drop "G".*

A quick retraction of the paddle will change the contour of "G" and "H", which attenuates at a point "J" where "H" is severed. A composition lined spout "K" receives drop and conveys it by gravity to reverse spout "M" where it is deflected and piped into blank mold "N".

A pipe and spray "L" provides a vapor of oil or water which protects the drop from contact with the spouts "K" and "M". Plunger "O" is inserted in blank mold as by Arbogast, and the finish made after which it is conveyed to the blow mold "P", having bottom plate "T" where the blank reheats and stretches to a point indicated by dotted line. After this cup "R" is placed on top of blow mold "P" and the bottle is blown to size, the cylindrical bottom plate "S" in blank mold is used to push the blank upwardly so as to permit tongs to convey it from the blank to the blow mold.



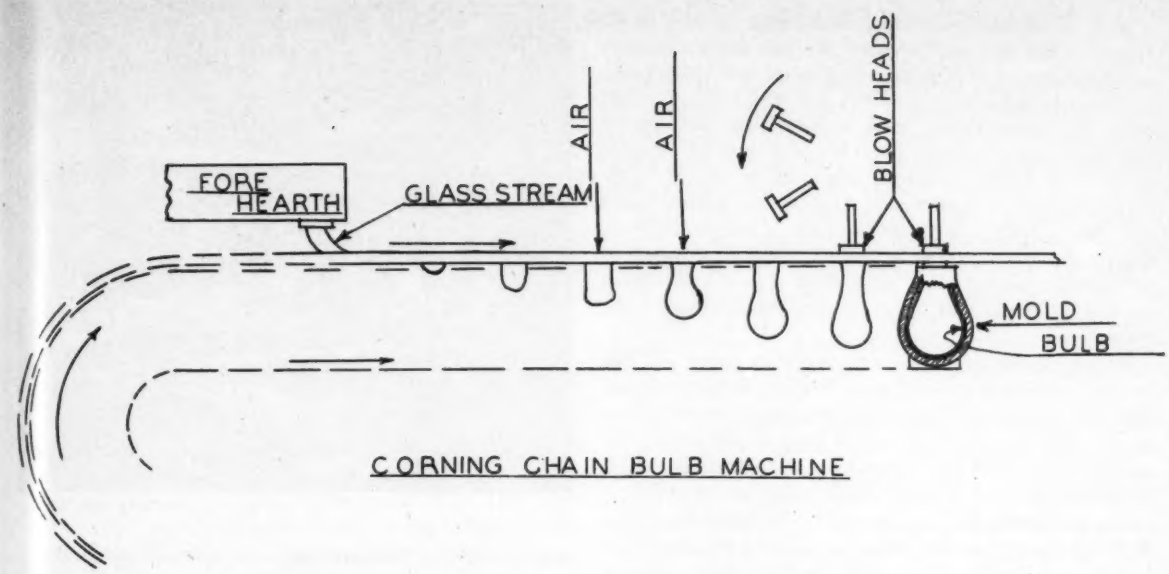
of container manufacture was disclosed by Arbogast in accurate detail in 1882 and although this important and revolutionary invention was practically ignored almost up to the turn of the century, realization of its value finally overcame the inertia of tradition.

What followed was more engineering than invention. To describe in detail the innumerable experiments, specific inventions and engineered designs which provided the necessary gadgets for the successful commercial operation of the Arbogast or blank system would not add particularly to the elucidation of my theme. Also space would not permit.

Machines were gradually perfected to a commercial stage and the completely automatic or *No Boy* type of machine became the prevalent method of manufacture. By completely automatic, we mean the operation of the machine without either skilled men or boys for blowing and final placing of the bottle on the lehr. However, these machines still had to employ hand gathering to fill the blank mold.

This filling or feeding of molten glass to the blowing machine by manual means prevented the automatic operation of the entire cycle and a continuous system. We have already explained how automatic feeding or gathering became the main object for invention and experiment by means of the hot thin flowing stream

Description of illustration left: *The plunger type gob is the modern system. It is an advantage over the paddle feeder gob which is evident from the sketches and accompanying notations. It gives control over the shape of the gob not possible with the paddle feeder and, therefore, the gob can be made to conform more nearly to the inside contour of the blank mold. The blank mold can be more completely filled and the objectionable settle blow noted in the sketch of the hand gather feed is eliminated or greatly reduced.*



CORNING CHAIN BULB MACHINE

finally culminating in the marvelous Owens system whereby complete mechanical automatism was achieved. Illustrated is a view of a plant operating continuously and automatically.

With this development, Michael Owens, the inventive genius, and Edward Libbey, the astute business man and financier, built up a great glass container empire producing at one time the majority of bottles made in the United States, and by license covered nearly every glass container producing country on the globe.

The story of this empire by the cooperative efforts of Libbey and Owens has recently been published in a book, "Revolution in Glassmaking" by W. C. Scoville, the perusal of which will repay any glassman. We are not concerned here primarily with stories of glass empires, biographies (auto or other) of inventors and engineers, but rather with the development of the theme that progress in the evolution of glass making is mainly due to following the basic law of evolution, "Efficiency in the Movement of Materials."

We have shown how plate glass manufacture steadily followed this law and how leaders in that division of the industry remained leaders mainly for that reason. We next showed how the window glass industry developed along the same path to a point where world-wide leadership was attained. Then came the decline and fall of this empire when another system more truly following this basic law forged ahead, rendering obsolete the system on which that empire was built.

Precisely the same thing happened to the container empire of Libbey and Owens, and for the same reason. The Owens system seemed impregnable well into the second decade of this century. But it had two fatal weaknesses. First, there were technical faults in the ware produced and which were inherent in the process. It was definitely passed by the gob system which reduced the technical faults in the ware by its process, and, most important, was more soundly based on the basic law of our theme.

As to the first, the technical faults in the ware were due to a) The use of the hot glass or stream feed whereby the blank tended to have a hard thin skin, and a relatively hotter interior so that, in reheating, the neck of the bottle tended to draw out and blow to an insufficient thickness. This was especially evident in ware having small diameter necks and wide shoulders. Ammonia bottles were an extreme illustration of this. b) The Owens system of suction gathering did not remove the chilled spot which proved so fatal to the gravity flow system of Brooke and others. It merely shifted it from the positions shown on the sketches of the Brooke system to the bottom of the bottle where it did not affect the corkage or body of the bottle. It did make rough unsightly bottoms and, more important, produced strains which caused bottles of certain types to break at that point. This was especially evident in milk bottles, and was a major cause of abandonment of the Owens system for the gob system in milk bottle manufacture.

On the other hand, while the Owens system had rough weak bottoms, this was later bettered and, to offset this defect, the body of the bottle was fine and clear without waviness which no other system has ever equalled. But the Owens system had to employ a revolving tank to reheat the chilled surface of the glass which was caused by the blank mold which dipped into it for filling by suction. This chilling and reheating was greater than the chill of the stream feed, and the cost of the revolving tank was too much to compete with the gob system which reheated the slight chill of the shear mark with only the glass in the gather itself. Here we see the "Materials Movement" principle operating.

As soon as the "Gob Feed" system could make bottles of comparable commercial quality, the Owens system was doomed. The handicap of the revolving tank was serious. The cost was about $80 per day additional over the gob feed system which eliminated this feature.

The sketches show the gob feed system. The Owens system used a hot liquid glass (stream fed); the other used a colder viscous glass capable of forming a gather suspended in air of suitable shape to fill the blank mold without undue chilling. The key to all glass working art is not machines or gadgets, but the physics or nature of the molten glass.

Karl E. Peiler was the pioneer and successful inventor of the gob feed system. We can neglect Steimer as his disclosure of a gob formed in air without support was impractical and incomplete, and was a paper patent only. However, Peiler made a disclosure that should rate him with Arbogast and Owens as one of the real pioneers of bottle making mechanization. Peiler's contribution was not a matter of gadgets, but a more basic one—the working of glass at such a temperature or degree of viscosity that a gather could be formed in air without contact with supporting means and with a contour or shape that approximated the contour of the blank mold.

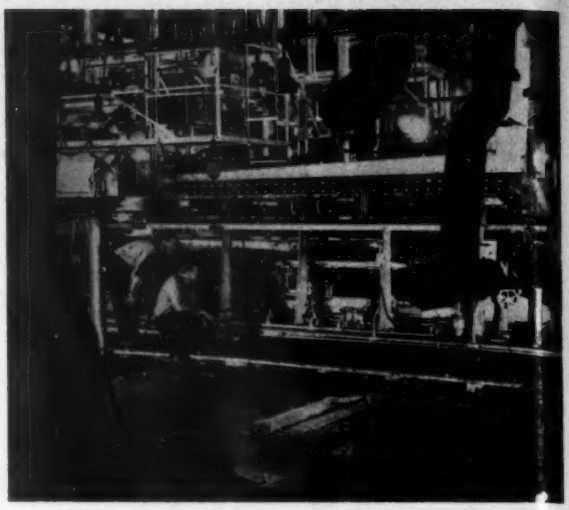
He employed, as means or gadgets to carry out this basically different cycle of glass feeding, certain original patented devices consisting of a forehearth, a refractory paddle with a movement which pushed the glass over the lip of his forehearth in a wave, thus forming a gob which moved down a vapor-lined trough into a mold.

The paddle feeder, and later the paddle needle feeder of Peiler, caused a revolution in the glass container industry, and Peiler was rightly credited and honored for his contribution to progress in developing a new art. The irony of the situation was that Peiler never was granted a patent on his basic invention which was based on natural law or physical characteristics (temperature and viscosity) of molten glass and as such was not patentable.

The patent office does not grant patents on natural law nor on the result obtained through the operation of such laws, but only on novel gadgets or novel combinations of gadgets which produce a new and useful result. The worship of gadgets or gadget-mindedness is such a fetish with inventors, engineers, patent attorneys and the public generally that Peiler's contributions were protected for their owners as long as it was felt that his invention (the gob system) consisted in a novel arrangement of gadgets used to obtain a new and useful result. But all the original gadgets were abandoned and the real invention (the gob system) did not fail to operate successfully but improved greatly. So gadgets had nothing to do with it. In fact, other gadgets were employed to effect the gob feeding operation which entirely lacked the original features of Peiler's paddle feeder. They were all well-known and had even been used in attempts to produce a successful glass stream feeding system except for hairline distinctions that merited the right to be called patentable inventions only by a vivid stretch of the imagination.

Then ensued the battle of the gadgets. Literally hundreds of inventions later embodied in scores of patents were engaged in a titanic struggle to control the gob feed system which finally developed into an airtight control of the glass container industry by the owner of patents granted to Peiler and others associated with him. This battle for control by patent of the glass container industry and the preceding battle for control of the window glass industry form a chapter in industrial mechanization that should justify a good sized volume for it is duplicated time after time in the story of the whole American industrial revolution.

However, the purpose of my theme is to develop the evolutionary *law* which determines the success of glass making mechanization. It is primarily concerned with



Corning Glass Works.

useful realities, forward steps in material civilization. It is not primarily concerned with the often fantastic wasteful and non-relevant manipulation of the laws and rules of practice in the patent courts, especially in interference proceedings which aim to establish the proper inventor.

Likewise, it is not primarily concerned with similar manipulations in the equity courts wherein the purpose is mainly to determine ownership of patents and the privileges which such ownership confers. Nevertheless, some mention of the basic factors involved in the pioneer concept of Peiler's gob feed and in the ensuing patent litigation is made to completely visualize this presentation.

Arbogast disclosed a basic concept which enabled the glass bottle to be made mechanically. This concept was not covered by his patent claims. Fundamentally, his invention disclosed the creation of a blank, an original and useful *article* not heretofore disclosed.

By comparison, Peiler disclosed and developed into commercial operation a similar concept, a useful *article* which was a gob or gather of glass suspended in air without contact with any other object. Neither the hand punty feed, nor the flowing stream feed which were *interrupted* streams, nor the Owens suction feed which was an *uninterrupted* stream, produced such an *article*.

But, as explained above, Peiler like Arbogast was not granted a claim on his basic *concept* and the battle over the ownership of Peiler's *invention* developed into a "battle of gadgets". This was a battle of *patents* rather than of basic *invention*.

Millions of dollars and tons of testimony were required to develop the hairline distinctions between the gadgets of Peiler and gadgets previously disclosed, distinctions often so fine as to be classed as patentable only by the vivid use of the imagination.

Patent litigation is tried in Federal court without a jury. The decision rests solely with the judges who have to settle cases on the basis of both law and equity. Here was a case where the real invention had revolutionized the art, but that determining factor could not be brought out because it was not embodied in claims in the particular patents under trial.

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NEW COUNCIL TO AID INDUSTRY IN TARIFF FIGHT

American manufacturers of glass and glass products pretty much held their own in domestic and foreign markets last year, suffering only minor losses against many adverse influences. However, the Administration's tariff policy is still considered a major threat to the industry and a recently organized labor-management group composed of trade associations and labor unions of varied industries, glass included, is expected to bulwark the fight for a reasonable tariff policy deemed essential to the preservation of the glass industry.

This effectively organized force working toward protection for glass and several other American industries threatened by low-priced imports is the new National Labor-Management Council on Foreign Trade Policy. This organization, expected to open a Washington office soon, includes trade associations and labor unions of these industries. These unions are AFL and some CIO unions have indicated interest in the Committee but have not up to this time declared their position with regard to active support of the movement.

This organization is gaining force, however (see page 201), and has the White House worried. Recently, in testimony on the appropriations bill of the Economic Cooperation Administration for the fiscal year beginning July 1, Secretary of State Dean Acheson publicly recognized, for the first time, some government responsibility for the adverse effect of low-priced imports on domestic industries. He told Congress that the government should pay subsidies to such industries. E. C. Hoffman, ECA Administrator, echoed the official apprehension by adding that workers who lose their jobs because of foreign competition should be trained by the government to do other work. He added that the government should teach local business organizations how to attract new industries, but did not explain who was capable of doing the teaching.

The membership of the National Labor-Management Council on Foreign Trade Policy, which includes glassware representatives, has been looking to support from agricultural interests in their fight on tariff reductions.

It may be, however, that the interests of farmers and food processors lie in another direction. Recently the National Milk Producers Federation influenced the Senate Committee on Agriculture to recommend an amendment to Section 22 of the Agricultural Adjustment Act to provide authority to impose quotas or import fees on imports. Also, various farm interests are pressing for approval of S. 3088, which would amend the Commodity Credit Corporation bill itself and provide for imposition of quotas and fees regardless of any trade agreement.

The primary purpose of the Committee on Foreign Trade Policy is to obtain a protective amendment to any bill or resolution approving the International Trade Organization charter. This amendment probably would provide for a system of "peril point" determination for industries hard pressed, or quotas where tariffs are already too low.

The industries and unions concerned could get behind a bill like H. R. 5766. This bill, sponsored by Representative Ramsay (Dem., W. Va.), would authorize payment of 50 per cent of import duties collected on pottery and glass products to domestic manufacturers in those industries as a subsidy designed to help them meet foreign competition. It is doubtful, however, that such a bill could be much help. Tariffs on many glass products are already so low that they do not begin to compensate for differences in costs of production.

H. R. 5766 is of interest now, however, because Secretary of State Acheson talks of subsidies, and it is quite probable that he was speaking for others than himself.

A summary of the most recent annual export and import figures follows: Glass and glassware shows that exports declined to $51,544,126 from the $58,800,000 of 1948, and imports increased to $7,367,612 from $6,438,806 in 1948.

Now the principal sellings points of domestic producers are quality and delivery and, in some cases, terms. Foreign producers, on the other hand, have these advantages: wages varying from 15 to 50 per cent of American wages, devalued currencies, forms of government subsidization in some instances, low U. S. import tariffs, higher foreign tariffs, and foreign quotas and licenses.

The spotlight is on imports of glassware and other low-priced products threatening a dozen American industries. The opposition against these imports is increasing fast, and has the Administration apprehensive. By 1952 this opposition may possibly, even probably, get some results.

Percentage-wise, however, exports are suffering a little more than imports. In addition to the handicaps to American exports listed above, glass and glass products factories are being established in many countries to satisfy domestic demands.

The table below presents data on exports and imports for 1949 as compared to 1948.

Exports Flat Glass	1948	1949
Plate glass	$3,136,459	$3,272,873
Cylinder, crown and sheet glass	3,413,494	2,237,298
Laminated glass and manufactures	484,027	784,388
Rolled glass, except colored	742,362	651,402
Rolled, cylinder, crown, sheet, colored	529,804	382,432
Other glass	3,367,563	1,377,821
Glass Containers		
Pharmaceutical and proprietary ware	4,019,978	4,517,639
Vials and ampuls	.....	498,626
Beverage bottles	13,906,398	10,966,677
Other containers, n. e. s.	4,127,682	3,604,329
	$22,054,058	19,587,271
Glassware		
Tumblers, drinking glasses, stemware	$2,354,173	3,295,390
Table and kitchen glassware	8,900,722	6,926,752
Chemical glassware	2,697,607	2,040,693
Glass products, n. e. s.	8,377,480	2,325,707

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IS GLASS A SUPERCOOLED LIQUID?

By WALTER HARWOOD

Weston, Ontario, Canada

Glass is often defined, or classified, as "a supercooled liquid". This means that, despite its appearance of solidity and hardness, it is merely an extremely viscid liquid. On this basis, the pane of glass before your eyes must be considered as slipping downward under the influence of gravity, though at such a slow rate that tens of thousands of years would be required to produce a visible effect. This last statement is correct; but some of its apparent implications are not. Glass is a slow motion-picture of a liquid "on the march". Many of the features of liquid flow have, in fact, been studied by the aid of this property of glass.

But glass is also highly rigid or stiff; far more so than steel. Because of its remarkable resistance to flexural and torsional strain-producing forces—in everyday language: bending and twisting forces—glass was used as the support for the metallic reflecting surface of the giant Mt. Palomar 200-inch telescope. If rods of glass and steel are fixed at one end and a bending moment is applied in cantilever fashion to the other, the steel bends through a distinctly larger arc, provided the test specimens correspond and the torques are equal. This arc provides the measure, or index, of the amount of shearing sustained by the test-specimen. (More exactly: the tangent of the arc; but, for small angles, the error caused by restricting one's attention to the angle itself is negligible.)

This simple experiment proves the superior flexural rigidity of glass. Liquids have enormous coefficients of bulk modulus—i.e. they are very resistant to forces tending to reduce their volume—but it is especially interesting to learn that a liquid, in apparent contradiction to its classification in the general category of "fluids", may show a smaller flow-response under shearing stress than steel. (Thick-bar cantilever tests measure both the bulk- and the shape-resistance of the specimen, so their evidential value in regard to the stiffness of glass is considerably less conclusive than the data afforded by rod tests.)

Since steel is made up of a conglomeration of crystals (with each crystal in turn consisting of rows of atomic walls), any force experienced by a steel specimen will have a component parallel to the faces of innumerable crystals thus tending to cause them to slide over one another. Even adjacent intercrystalline walls may tend to slip. (These inner walls slip in packets, not individually. This explains why, in an etched and polished specimen, they may be seen as dark lines when studied by means of an ordinary microscope.) But neither the one kind of surface-pair nor the other is to be found within glass for it has no inner surfaces. It is a solution: a mixture so homogeneous and uniform that it is optically void. Also it is to be noted that real solids, as contrasted with the ideal substances considered in many physical theories, are riddled with flaws. Only in a liquid are these defects absent. "A chain is as strong as its weakest link," but glass, being a liquid, may be said to be just one single link, so its strength is uniform throughout. This explains the rigidity of glass, yet all the while it is flowing down to the sea.

When undergoing flexural or torsional treatment, steel "flows" a short distance in response to moderate shearing forces and then comes to a stop. In the same circumstance, glass starts into action as if to outdistance the steel but, moving ever more sluggishly, falls behind in the race—hence the lesser amount of yielding displayed. Oddly enough, though, the glass never ceases to advance, but, after the first short distance of movement, its creeping progress is so tardy that for practical engineering purposes it may be forgotten to exist. The direction of this flow, in the instance of cantilever bending, is entirely determined by gravity forces, so it must be seaward. Perhaps it ought to be remarked that Harold Jeffreys and others have definitely disproven a belief prevailing in some quarters: namely that, given sufficient time (measured in eons), a feeble force can overcome the shape-resistance of ordinary solid materials. Glass *seems* exceptionally distinct in this respect but, as we have seen, it is not really a solid.

Hit a steel bar with a hammer. The atoms immediately beneath the point of impact will be highly energized by the work performed upon them and, as a consequence, their bonds of cohesion are destroyed. They become a liquid or even a gas. But the advancing wave of pressure—to confine our attention to just one out of many—successively runs into hundreds, thousands or even millions of walls both within and at the surface of the crystals encountered along its path of progress. Finally, with its energies depleted, the wave strikes a wall and sets it vibrating, but does not break it down. The total damage accomplished is superficial. Now hit a bar of glass. This fracture also spreads through the material until it reaches a wall, but this first wall is also the last for it is at the opposite surface of the glass. The bar has been cracked right through. Thus the associated properties of hardness (rigidity) and brittleness—so often commented upon—are explained. Glass is transparent, hard and brittle because, from the one side of a test specimen to the other, exactly *two* walls are encountered.*

Supercooled solutions and liquids are familiar phenomena. Suppose a quantity of some kind of salt is completely dissolved in water at a high temperature. When the solution is cooled, a point is soon reached that, for the prevailing condition of temperature and pressure, all the salt cannot remain in solution, and the excess is precipitated in the form of an aggregate of crystals. If the cooling process is gradual, and if the vessel containing the solution is clean and smooth, it is possible to "sneak" a few degrees below the precipitation-point temperature before anything happens but, when precipitation does occur, it proceeds rapidly, with the

* So far as transparency is concerned, the observation might be made that a hollow cube of polished silver containing a perfect vacuum also confronts an advancing light-ray with only two walls, so the cube ought to be quite transparent. A large part of the answer to this criticism is that silver, like metals in general, contains free electrons—about one per atom—and this provides the impacted wall on the front of the cube with a reflecting mechanism of nearly perfect efficiency. And the wall, when examined, would be revealed as constructed of many crystalline layers, each in turn containing innumerable arrays of atomic barriers neatly lined-up in opposition to the progress of the light.

evolution of heat, until the concentration of the solution is reduced to the degree of intensity normally corresponding to the prevailing temperature. During the passage through the "dangerous" last few degrees, the solution is said to be "supersaturated" or supercooled. ("Undercooled" would seem to be better.)

Pure water may also be supercooled. That is, if its temperature is reduced gradually, it may be lowered below 32 F. or 0°C. at normal atmospheric pressure without freezing. But the inevitable can be delayed just so long and no longer. If the temperature is reduced still further, or if the containing vessel is jarred, ice forms rapidly, heat is released and crystallization proceeds until the water becomes a frozen mass.

Let us now cool a pot of molten glass and see what happens. Originally the various atoms of the solution, as is characteristic of liquids some distance above their freezing points, are possessed of no kind of ordered relationship, except that, owing to atomic repulsion, the separation-distances of the atoms cannot fall below a certain minimum. This disordered state is responsible for the transparency of the liquid glass, for it means that owing to the averaging-out of differences one microscopic volume of the liquid is the same as any other. As remarked earlier: there are no internal walls, so far, at any rate, as may concern the electromagnetic waves within the spectrum-range designated as "light". Obviously the method of testing to determine the optically void state—whether an ordinary, an oil-immersion or an ultra microscope is used—cannot provide evidence about the parts of the spectrum outside of its range of probing.

As the glass cools, the atoms lose their kinetic energy, and the forces of attraction between them threaten to take command of the situation thereby producing the ordered crystalline state with the atoms arranged in successive walls—often arrayed at regular angles other than zero in relation to one another—but with the individual crystals more or less jumbled together. When this actually happens, the glass is said to have "devitrified" and it ceases to be transparent. With glasses in general, and borosilicate and high-silica-content glasses in particular, it needs scarcely to be said that this is easy to avoid.

As the molten glass cools, it becomes ever more viscid so that the tendency of the atoms to line-up in response to mutual attractive forces is resisted by the increasing stickiness of the medium. The danger of these forces gaining victory is non-existent at high temperatures because the atoms are too energetic to be controlled, while at low temperatures they are too thoroughly glued into place to be able to respond. Briefly expressed, at high temperatures the atoms won't line up; at low temperatures they can't. A disciplined army cannot be made up from either a mob of maniacs or a jumble of corpses.

Probably most engineers would agree that glass is a supercooled liquid. But, in view of the analysis given in the preceding paragraph, this idea is seen to be definitely erroneous. It is true only while the glass, in the process of cooling, is within the devitrification range, and this constitutes no more than a short strip of the entire cooling-curve. A supercooled liquid is constantly in danger of crystallizing; a glass is not.

Has a glass, then, no tendency to undergo any kind of reorganization? This question may be shown to be incorrectly worded.

The lens of a refracting telescope is a highly expensive proposition. (Readers of Dreiser's novel *The Titan* may recall that, even in the 90's of the last century, the cost of a 40-inch lens was estimated at $40,000.) One way of drastically reducing the price of a lens would be to construct it out of a number of pieces of glass. As the reader knows, this stunt will not work. No matter how closely the proportions of the various ingredients may be controlled, no two batches of glass ever have the same refractive index. If pure silica is used, the indices are still inconsistent from one sample to the next. We are now in possession of the requisite hint as to the answer to the problem.

The atoms of a molten glass are in a completely disordered state: except, as earlier noted, for a certain atomic-separation minimum. As the glass cools, its atoms slow down, so the atomic-spacing variety attributable to their motion is reduced. The increasing viscidity of the melt means that, at each successive lower-temperature stage, the disordered state corresponding to that stage is increasingly likely to become frozen in, like a highspeed motion-picture beginning to run down, and then abruptly coming to a stop. To continue the analogy, a study of the geometrical relationships of the stationary atoms on the screen would reveal their velocity distribution and, hence, the "temperature" of the picture at the instant of stopping.

Finally the glass becomes cold, and it is now far below its freezing-in temperature. The haphazard atomic-disorder of the glass corresponds, not to its present temperature, but to a much higher one. (This haphazard state means that the glass contains no molecules. An unbroken pane of glass is a molecule in itself. If broken, then each fragment is a molecule. This, incidentally, answers the question recently asked by Charles F. Kettering: "Does the light come through the pane of glass, or is it rebroadcast from molecule to molecule?") Any self-induced changes occurring within the glass will bring it into closer adjustment with the disordered state corresponding to the prevailing temperature. "Solid" glass has no more tendency to crystallize when well below the short devitrification range than it has when, in the completely liquid condition, it is high above this range. The tendency is to change to another disordered state. Such a change could scarcely be called a *reorganizing* process.

Glass is simply a liquid—*not* a supercooled liquid. Nor is it "a fourth state of matter". It drips downward and flows along, conforming, meanwhile, to the shape of its supporting surface just like any other liquid. It differs from other liquids in this respect: as it flows, it undergoes a succession of transformations, each one bringing it closer to the kind of liquid corresponding to the prevailing temperature.

Glass is regarded as a solid because of the brevity of human life. You may recall the comment of a certain British philosopher: "Life's only consolation is its brevity".

• F. S. Jones has been elected Vice President in Charge of Sales for The Colorado Fuel and Iron Corporation, according to an announcement by Carl W. Meyers, President. James N. Counter has been named to fill Mr. Jones' previous position of General Manager of Commercial Steel Sales of the Western Division.

OPTICAL SOCIETY HOLDS WINTER MEETING

The winter meeting of the Optical Society of America was held at the Hotel Statler in New York City on March 9, 10 and 11.

Invited Papers

The convention was opened with an invited paper by Professor G. B. B. M. Sutherland of the University of Michigan. His paper was "Recent Work on the Two Forms of Diamond". The paper pointed out that spectral studies and x-ray studies indicated that diamond exists in two forms and went on to explore several explanations which have attempted to account for these differences.

Other invited papers were: "The Role of Quanta in Ordinary Optical Phenomena" by Dr. Richard P. Feynman of Cornell University, and "Visual Aspects of the CBS Color Television System" by Dr. Peter C. Goldmark of the Columbia Broadcasting System. Dr. Feynman had an interesting paper concerning a few experiments in which paradoxical results were obtained. From this he proceeded to show that statistical methods lead to consistent results and that the usual laws of optics hold. Dr. Goldmark's paper reviewed some of the problems of television and led up to some of the resulting methods of transmitting color television. The paper indicated the relative merits of the various systems of color television as they had been measured by CBS.

Large Glass Discs and Windows

John T. Watson (Boston University) and Vincent Young (Bausch and Lomb Optical Co.) presented a paper "Optical Quality in Large Glass Blanks". This paper described the quality of glass procured for a large aerial camera which ranged in size to 33 inches diameter and over 3 inches thick. Glass for the lenses was obtained from Schott Glass Co. and the authors had investigated large pieces produced by Bausch and Lomb Optical Co.

The glass from Schott was delivered with only a few fine striae. Index of refraction measurements have been taken from discs which were broken by Schott in manufacture, 10 to 20 samples per disc varying as little as one part and as much as three parts in the fifth place. A differential refractometer developed at Boston University indicated that the delivered discs were within five parts in the fifth place. Annealing has left more than 5 millimicrons per centimeter of strain but in a symmetrical pattern.

The authors reported that Bausch and Lomb Optical Co. is producing homogeneous discs of 26 inches diameter and 2½ inches thick. Index measurements made on nine prisms made from a broken 36-inch disc showed no variation in the fifth place. Fundamental research of Bausch and Lomb and Mellon Institute in methods of annealing indicated that schedules can be determined for plates up to three inches thickness which will give glass homogeneous to a few parts in the sixth decimal place and with 1-5 millimicrons per centimeter of birefringence.

In a paper, "Deterioration of Image Quality by Photographic Windows" by John T. Watson and William C. Britton (Boston University), a report was given of an investigation of glass for a window in an airplane through which a long focal length camera was to operate. Tests indicated that plate glass was nearly as good as specially prepared discs except that image quality deteriorated more off axis or when the glass had pressure applied to it.

Photosensitive Glass

A paper "Photosensitive Glass" by S. D. Stookey (Corning Glass Works) presented for the first time before the Optical Society the interesting glass developed by Corning. The paper described the two types of glass which have been developed: the ruby type and the opal type. The methods of using the glass photographically and the processes involved were discussed. Other uses for the glass in specially designed lighting fixtures were presented.

Optics

Several papers were given of interest to that phase of glass industry concerned with optics. Donald F. Feder's (National Bureau of Standards) paper "Method of Tracing Skew Rays" outlined a vector method which provided a simple method for tracing skew rays through a system of spherical refracting surfaces. L. Ivan Epstein's (Bausch and Lomb Optical Co.) paper "Calculation of Third Order Aberrations with the Aid of IBM Machines" described a method for placing data concerning each optical surface of a system on a punched card, and obtaining on another punched card the resulting aberrations of the system. Eric M. Wormser (Servo Corporation of America), in a paper "On the Design of Wide Angle Schmidt Optical Systems", described a simpler method of determining the curve of a corrector plate than that usually used.

Color

For color followers there were a number of papers of interest too. F. J. Bingley's (Philco Corporation) "The Application of Projective Geometry to the Theory of Color Mixture" suggested the use of geometrical methods for the solutions of some color problems. The paper was presented from the standpoint of a problem in color television, but the method was applicable to a broader field. No doubt most people concerned with color have used projective geometry in the solution of some problems, but the method given in this paper was unusual.

Two papers making use of the Hunter Color-Color Difference Meter were presented. S. G. Younkin's (Campbell Soup Company) paper "Application of the Hunter Color Difference Meter to a Tomato Color Measurement Problem" indicated they found the instrument capable of rapid, repeatable, small color differences. The paper of D. L. Nickerson (National Bureau of Standards), Richard S. Hunter, and Marshall G. Powell (H. A. Gardner Laboratory), "New Automatic Colorimeter for Cotton", described an automatic application of the Hunter instrument. Cotton colors were found to be expressible in only two coordinates of Hunter's Color Space. A self-standardizing instrument was described, which recorded

on a chart the location of a sample in a limited portion of the Hunter color space. "Color Harmony Manual: Colorimetric Analysis of Third Edition" by W. C. Granville (Container Corporation of America), C. E. Foss (Princeton, New Jersey), and I. H. Godlove (General Aniline and Film Corporation) reported on the third and latest edition of the Color Harmony Manual.

Other papers of general interest to those in the field of color were W. E. Knowles Middleton's (National Research Council of Canada) paper on "The Colors of Distant Objects" and D. L. McAdam's (Eastman Kodak Co.) paper "Loci of Constant Hue Determined with Various Surrounding Colors". These papers although not directed toward glass problems were very interesting.

Crystals

Since some glass people have now become interested in the use of crystals, one must mention several papers related to crystals. K. A. McCarthy and S. Ballard (Tuft's College) described an apparatus which they had constructed to measure the thermal conductivity of optical crystals. The name of their paper was "Measurements of the Thermal Conductivity of Optical Crystals". L. S. Combes and S. S. Ballard (Tuft's College) also reported on "Studies of the Inelastic Behavior of Optical Crystals". In this paper they described their procedures in measuring cold flow in the crystals and indicated some crystals show a two step deformation with time and some show a three step deformation.

Two other papers on crystals were presented: "Refractive Indices of Rutile and Sphalerite" by J. R. DeVore and "Color Centers in Fused and Crystalline Quartz" by Alexander Smakula.

Calculators

Several calculators were described which must be mentioned. The first of these was described by S. M. MacNeille and E. O. Dixon (Eastman Kodak Co.) in the paper "Electrical Computer for Calculating the Optical Properties of Multilayer Interference Films". The instrument described represented the amplitude and phase of a light wave by the similar properties of an A. C. voltage. A separate network was provided for each film of the system. The instrument was used to solve problems of light transmission and reflection in systems in which the angle of incidence, polarization and absorption were factors.

The second instrument was described by W. E. Knowles Middleton in the paper "A Curve Computor". In this paper an instrument was described in which the ordinates of two curves could be added, subtracted, multiplied, or divided. The curves were attached to a moving table and followers made to follow the two curves as the table was driven. The followers were attached to precision resistances in a Wheatstone bridge circuit. The table also carried a sheet of graph paper on which a pen, attached to the balancing resistance of the bridge, traced the resulting curve. The bridge system was kept in balance by a servo-mechanism.

A number of papers were presented on films and interference filters. There were several papers on phosphors and fluorescence of transparent bodies and a paper on further improvements in high speed photography. One meeting on ruling engines attracted so many conventioners that the speakers at the other concurrent meeting were almost the only ones in attendance.

The usual dinner session was held on Friday night. The speaker was Dr. Newborn Smith of the National Bureau of Standards who spoke on "Developments in the Field of Color Television".

This session of the Society lacked invited papers. At some of the sessions there has been at least one invited paper each half day. This policy has much to commend it. Very frequently the invited papers are useful reviews in the fields where we cannot all keep up.

In reference to the contributed papers, it is encouraging to see the trend in which junior authors, who no doubt do much of the work, have the opportunity to present the papers.

THE INTER-SOCIETY COLOR COUNCIL

The Inter-Society Color Council held its 19th annual meeting at the Statler Hotel in New York on March 8, 1950. The chairman of the Council this year is Dr. Isay Balinkin who represents The American Ceramic Society. The Ceramic Society laid aside its rule of rotation of its delegates in order that Dr. Balinkin could serve this term as chairman. Other representatives of the Ceramic Society in attendance were: R. Guy Cowen, Richard S. Hunter, M. G. Yutze and Tyler G. Pett.

The morning was devoted to a business session and committee reports. Current problems with which the council concerns itself include "Color Names", "Color Specifications", "Color Aptitude Test", "Illuminating and Viewing Conditions in the Colorimetry of Reflecting Materials", and "Transparent Standards Using Single Number Specifications". In addition to the purely organizational reports, reports were received from nearly every member organization of which there are twenty. The Gravure Technical Association, Inc., was voted membership in the Council at this meeting.

The afternoon session was devoted to a series of four invited papers which were: "Color Problems in Industrial Design" by Scott Wilson, "Color Problems of the Architect" by Waldron Faulkner, "Color Problems of the Decorator" by Karl Bock, and "The Dynamic Use of Color" by Egmont Arens. The content of these papers was of greater interest to designers than to technical people. The one point which stood out was the necessity of being able to predict color and design trends in advance in order that a product when finally produced will be "in style".

This year's meeting included a dinner session which had been named "Operation Rainbow". The dinner was a huge success, served on colored plastic coated paper plates, from tables covered with colored plastic cloths. The menu had been selected from highly colored foods, and some artificial coloring was introduced. Many colored items had been donated by various manufacturers so that almost every one received a "pot of gold at the end of the rainbow".

The speaker at the evening session was Ralph M. Evans who gave his very excellent lecture on "Seeing Light and Color". His use of colored slides made the lecture almost a moving picture. Mr. Evans started by illustrating various points from physics, physiology and psychology and then proceeded to show that experience is one of

(*Continued on page* 223)

PATENT EQUITY GROUP IS ORGANIZED TO LEAD DRIVE FOR SPECIAL COURTS

The Patent Equity Association, Inc., has been formed to lead a campaign for special Federal patent courts, manned by judges with technical training, it has been announced by T. Irving Potter, President of the new organization which has been chartered as a non-profit New York corporation.

Mr. Potter is President of the management counselling firm of Potter & Halsey, Inc., and has received more than fifty patents, chiefly in the refrigeration field.

Other founders of the association include Edwin H. Land, President of the Polaroid Corporation, Cambridge, Mass.; Clarence Birdseye, Birds Eye Frozen Foods, Gloucester, Mass.; and John Hays Hammond, Jr., holder of many patents in electronics.

Mr. Potter said that the association would seek these three changes in the adjudication of patent suits: 1) Special Federal patent courts at the district level; 2) A special court of patent appeals within the present system of Federal courts; 3) Appointment of judges for those courts on the basis of education and experience in science, engineering and patent law.

"Patent suits today are too technical to be adjudicated by men without scientific or engineering background," Mr. Potter said. "No general lawyer would think of handling a patent case because he realizes that patent law is a complex specialty. Yet we have assumed that a judge without any training or experience in this specialty can mete out justice in patent suits.

"A patent today is not the incentive that it was when Bell and Edison rose to fame. Even such geniuses would find it difficult to thrive under our present weakened patent protection. We have seen patent applications decline by almost 50 per cent in the last twenty years. America's technological supremacy is threatened by the costliness of patent litigation.

"The concept of the patent system and the basic patent laws are sound, but they have been largely vitiated by judicial interpretation. The time has come to revive the incentive which the patent system was intended to provide to inventors, manufacturers and investors."

UNIVERSITY OF WASHINGTON OFFERS FELLOWSHIPS

The University of Washington is offering five fellowships in the School of Mineral Engineering for research in Coal and Non-metallics in cooperation with the United States Bureau of Mines, according to a statement from that department. In addition, an Edward Orton, Jr. Fellowship in Ceramic Engineering and several Engineering Experiment Station Fellowships in Metallurgy and Ceramics are being offered.

The fellowships are open to graduates of universities and technical colleges who are qualified to undertake investigations of research character. The investigations consist principally of laboratory work directed largely by the Bureau's technologists.

CORRECTION: On Page 129 of the March 1950 issue of THE GLASS INDUSTRY, the third line of column two states erroneously ". . . has decided to use capacity at 70°F (21.1°C) as the . . ." The temperature capacity in this sentence should read: 60°F (16°C).

OUTSTANDING PHOTOGRAPHERS TO SELECT CAMERA CLUB SALON WINNERS

Judges for the 11th annual Photographic Salon of the American Ceramic Society's Camera Club to be held at the Hotel Statler, April 23 to 27, are three outstanding New York photographers.

Lloyd E. Varden, F. R. P. S., F. P. S. A., F. B. P. A., is technical director of Pavelle Color, Incorporated; Victor H. Scales, Hon. P. S. A., is past president of the Metropolitan Camera Club Council and a well known photographic authority; and Jacob Deschin, F. R. P. S., A. P. S. A., is the internationally known Camera Editor of the New York Times. Among his many publications is the recent book "Say It With Your Camera".

Scheduled to be the largest salon hung by the Ceramic Camera Club, this year's event will be an outstanding feature of the Annual American Ceramic Society Convention. All members of the American Ceramic Society are eligible to compete, as are all employees working for firms that hold Society Membership.

Closing date for the contest is April 21, 1950. Entry blanks are available at the offices of the American Ceramic Society, Columbus, Ohio.

GLASS COMPANY ANNUAL REPORTS

Among the Annual Reports received from glass companies, the Libbey-Owens-Ford Glass Company reached an all-time record of net earnings in 1949 totaling $20,985,001, equal to $8.20 a share, after charges for maintenance, taxes and increased allowances for depreciation and obsolescence. The earnings compare with $14,207,338, or $5.56 a share, in 1948. The Report discusses the activities of the various Divisions of the firm and illustrations of new buildings which employed Thermapane in construction, as well as the vital statistics.

According to the Annual Report issued by Thatcher Glass Manufacturing Company, net income for 1949 was $924,140 as compared with $176,864 for 1948. The Report discusses the firm's operating standing at the close of 1949, and shows a colorful graph featuring wages and salaries, net income and taxes.

Sales and earnings for Pittsburgh Plate Glass Company were at all-time highs for 1949. Net income was $38,135,088, equal to $4.22 a share, as compared with 1948 net income of $32,748,900, equal to $3.65 a share. The heavily illustrated two-color report shows various PPG plants and several buildings which use Pittsburgh Plate Glass products in construction. Employee, plant and community relations are also discussed.

Corning Glass Works' Annual Report also indicated a high and its 1949 sales for 1949 broke all records. Net earnings for last year, after all charges and taxes, amounted to $7,078,384, or $2.56 a share on common stock. In 1948, earnings were $3,648,253, or $1.25 per share in 1948. The all black and white Report tastefully illustrates various glass products produced by Corning and the center spread is devoted to illustrations of existing and proposed plants of the company.

• Libbey-Owens-Ford Glass Company has declared a dividend of $1.00 a share payable March 10 to shareholders of record February 27. In the first quarter last year, a dividend of 75 cents was paid.

INVENTIONS AND INVENTORS

A Summary of Recently Issued Patents of Interest to the Glass Industry

Feeding and Forming

I. S. Machine Take-out. Fig. 1. Patent No. 2,500,083. (3 sheets of drawings.) Hugh MacConnell, Jr., assigned this invention to Hartford-Empire Company. The take-out includes two bottom plates which cooperate alternately with the blow mold. At the time that the bottle is being blown, suction is applied through the bottom plate to exhaust the air from the mold. The vacuum is continued while the bottom plate swings to remove the bottle from the mold and to transfer it to a position to be picked up by tongs which deposit it on a conveyor.

In the figure, the blow mold 1 is the usual I.S. blow mold. A pair of bottom plates 7 and 8 are carried on the opposite ends of a carrier 9 arranged to be turned through 180° by mechanism connected to a shaft 10. The bottom plates are directly mounted on arms 27 and 28 on the ends of the carrier 9 and a gear mechanism is provided so that the bottom plates are always in horizontal position.

In the operation of this device, suction is applied through the bottom plate while the bottle is being blown. This suction continues while the bottom plate is turned through 180° carrying the bottle in upright position into the position shown by dotted lines where it is picked up by tongs 14 and delivered to a conveyor or a dead plate 13.

The following references are of record in the file of this patent: United States Patents: 1,854,408, Kadow, Apr. 19, 1932; 2,161,750, Schonwald, June 6, 1939; 2,284,796, Berthold, June 2, 1942; and 2,438,088 Wyss, Mar. 16, 1948.

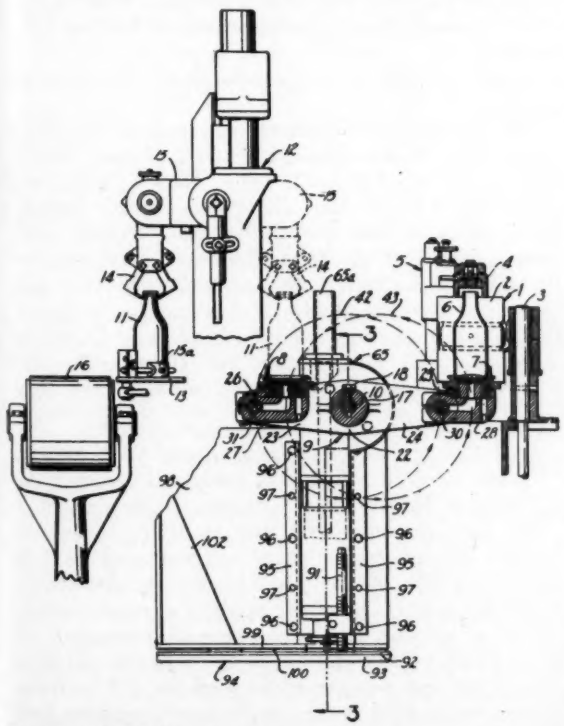


Fig. 1. I. S. Machine Take-out.

Laminated Bottle Machine. Fig. 2. Patent No. 2,500,105. (Five sheets of drawings.) Walter C. Weber assigned this invention to Hartford-Empire Company. The patent discloses a method of making bottles and the like having laminated walls made up from glasses having different characteristics. By using glasses having different coefficients of expansion to form the layers, a bottle having a strength equal to or greater than tempered glass may be produced. Cane made by this method has been increased in strength as much as 350%.

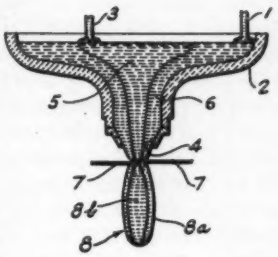


Fig. 2. Laminated Bottle Machine.

The figure shows a rotating bowl 2 of a glass feeder, to which a stream 1 of low expansion glass is fed and a stream 3 of high expansion glass which is fed to the bowl nearer the center. This forms a core 5 surrounded by an outer layer 6 of low expansion glass. The gob is formed in the usual way as by a plunger and, while suspended, is severed by shear blades 7. This gob consists of an outer layer 8a of low expansion glass and an inner layer of high expansion glass and it will be apparent that any article shaped from this gob will have the two layers of glass incorporated.

The final shaping of the ware may be by pressing or blowing or a combination of the two. The patent also discloses a feeder for making ware having several layers of glass having different characteristics instead of the two layers here shown.

The following references are of record in the file of this patent: United States Patents: 460,358, Butler, Sept. 29, 1891; 1,529,947, Freese, Mar. 17, 1925; 1,547,715, Baker, July 28, 1925; 1,715,130, Haley, May 28, 1929; 1,760,254, Peiler, May 27, 1930; 1,770,335, Fuwa, July 8, 1930; 1,828,226, Hiller, Oct. 20, 1931; 1,828,229, Marsh, Oct. 20, 1931; 1,828,443, Rankin, Oct. 20, 1931; 1,832,491, Locreille, Nov. 17, 1931; 1,873,866, Barker, Jr., Aug. 23, 1932; 1,960,121, Moulton, May 22, 1934; 1,997,798, Kucera, Apr. 16, 1935; 2,062,623, Wadsworth, Dec. 1, 1936; 2,164,184, Wadsworth, June 27, 1939; 2,166,563, Wadsworth, July 18, 1939; and 2,177,336, Shover et al., Oct. 24, 1939. Foreign Patents: 1,268, Great Britain, A. D. 1780; 494,452, Great Britain, Oct. 26, 1938; 612,120, France, July 24, 1926; and 849,842, France, Aug. 28, 1939. Other References: *Glass, the Miracle Maker*, Phillips, published by Pitman Pub. Co., New York, 1941. Pages 169, 170, 189 and 190. (Copy in Div. 5.)

Glass Compositions

Blue Glass. Patent No. 2,498,387. (No drawings.) Corning Glass Works acquired this invention from Wil-

liam H. Armistead. The invention relates to borosilicate glasses such as shown in Patent No. 1,572,625. The inventor has found that glasses according to the above patent do not refine satisfactorily when a blue color is desired. Glass of the new composition may have the depth of color varied by changing the amount of cobalt.

The patent claims a blue glass composed of 15% to 76% SiO_2, 12% to 80% B_2O_3, 2% to 18% alkali metal oxide selected from the group consisting of K_2O, Na_2O Li_2O and mixtures of a plurality thereof, Al_2O_3 in an amount up to 5%, cobalt oxide in an amount less than 0.3%, and chlorine, the amount of chlorine, analytically determined and computed as Cl, being slightly in excess of the stoichiometric amount required to form $CoCl_2$ with the cobalt in the glass, said glass also containing a divalent metal oxide selected from the group consisting of BeO, CaO, ZnO, SrO, CdO, BaO and PbO in an amount less than 1%.

The only reference cited by the Patent Office was Taylor, No. 1,572,625 dated Feb. 9, 1926.

Vitreous Enamel. Patent No. 2,500,231. (No drawings.) This invention was assigned to National Lead Company by William J. Baldwin of Snyder, N. Y. The invention relates particularly to a mill addition opacifier for use with zirconium opacified enamel frits which develop opacity on heating in the enameling cycle.

One example of this opacifier is a batch made up as follows:

	Parts by weight
Amblygonite	53.5
Aluminum hydrate	54.5
Zirconium oxide	22.4

which corresponds to an oxide formula of:

	Per cent
P_2O_5	25.0
Al_2O_3	53.5
ZrO_2	21.5

or an approximate molecular formula of

$$ZrO_2 . P_2O_5 . 3Al_2O_3$$

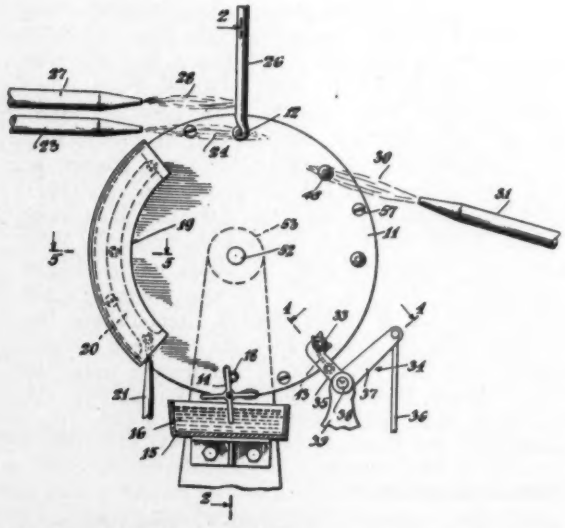


Fig. 3. Bead Making Machine.

This was ground and added to a frit comprising:

[Ingredients in per cent]

SiO_2	30
ZrO_2	14
TiO_2	0.1
Al_2O_3	9
ZnO	3
CaO	8
P_2O_5	2.5
B_2O_3	18
F	5
K_2O	2
Na_2O	13

The patent gives directions for preparing and using this composition which results in an enamel having superior qualities.

The following references are of record in the file of this patent: United States Patents: 1,314,831, Preusser, Sept. 20, 1919; 2,252,588, Whitesell, Aug. 12, 1941; and 2,347,187, Frost, Apr. 25, 1944.

Miscellaneous Processes

Method of Coloring Glass. Patent No. 2,498,003. (No drawings.) Milton M. Peterson assigned this invention to Corning Glass Works. The invention relates to the treatment of glass so as to produce a red color on the surface which method is commonly known as "copper staining" or "red etching". The method of this patent purports to produce the desired red color quicker and more uniformly in distribution.

Claim 1 of the patent is as follows: The method of obtaining a uniform coloration in the copper-staining of a soda-lime-silicate glass, which comprises first heating the glass in a reducing atmosphere, and thereafter applying a staining composition containing a compound of copper to the glass and heating the glass while in contact with said staining composition to develop color therein.

Details for practicing the method are found in the patent.

The following references are of record in the file of this patent: United States Patents: 2,075,446, Leibig, Mar. 30, 1937; 2,233,622, Lytle, Mar. 4, 1941; and 2,314,804, Willson, Mar. 23, 1943. Foreign Patents: 4,880, Great Britain, Nov. 1878 and 328,520, Great Britain, May 1, 1929. Other References: *Handbook of Chemistry and Physics*, 29th edition, page 314, published by Chemical Rubber Publishing Co. (Copy in Div. 38.) *Partington Textbook of Inorganic Chemistry*, 5th edition, 1937, pages 602 and 913. (Copy in Div. 38.) *Hackh's Chemical Dictionary*, 3rd edition, 1944, page 75. (Copy in Div. 38.)

Bead Making Machine. Fig. 3. Patent No. 2,498,365. (2 sheets of drawings.) Paul Ganzinotti assigned this invention to Hudson Pearl Company, Union City, N. J.

The machine comprises a disc 11 having a series of spindles 12 near its periphery and extending on both sides of the disc. As the disc turns, the spindles are engaged by paddles 14 which apply a coating material 16 to the spindles for the purpose of preventing the glass, which is later applied, from sticking to the spindles. Lime and water may be used for this purpose. The coating is dried as the spindles pass through an oven 19.

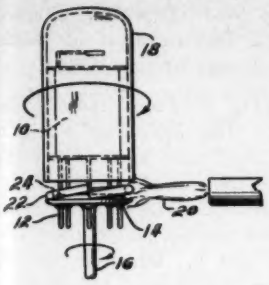


Fig. 4. Sealing Electron Discharge Devices.

The dried coating is heated by a burner 23 after which it comes in contact with a glass rod 26 heated to the softening point by a burner 27. The glass winds on the spindle and is heated again by the burner 31, suitable means being provided to rotate spindles. The bead has hardened by the time it reaches an ejector mechanism 33 which strips the bead from the spindle. In this way spherical perforated beads or buttons may be made.

The following references are of record in the file of this patent: United States Patents: 601,062, Neuss, Mar. 22, 1898; 857,151, Booth, June 18, 1907; 1,391,527, Chase, Sept. 20, 1921; 1,466,575, Bonnet, Aug. 28, 1923; 1,574,383, Fraser, Feb. 23, 1926; 1,580,076, Paisseau, Apr. 6, 1926; 1,789,014, Millar, Jan. 13, 1931; 2,348,035, Synek, May 2, 1944; and 2,348,036, Synek, May 2, 1944. Foreign Patents: 630,452, France, Oct. 23, 1927.

Refractory Composition. Patent No. 2,498,622. (No drawings.) This refractory is intended for use in contact with molten glass. It is the invention of John M. Mochel who assigned it to Corning Glass Works. The composition is mixed and molded in the usual manner by slip casting or pressing. After drying, it is fired at a temperature of 1550°C. or higher.

The following table gives 15 examples in percent by weight, coming under the patent:

No.	Cr_2O_3	TiO_2	CaO	SrO	BaO	Apparent Density	Percent Voids	Ratio TiO_2/RO
1....	85	12	3	..	..	4.38	13	4/1
2....	90	8	2	..	..	4.51	12	4/1
3....	95	4	1	..	..	4.14	16	4/1
4....	97.5	2	.5	..	..	3.82	26	4/1
5....	98.75	1	.25	..	..	3.63	29	4/1
6....	96	2	2	..	..	3.34	36	1/1
7....	95	4	..	1	..	3.63	30	4/1
8....	94	4	..	2	..	3.89	25	2/1
9....	93	4	..	3	..	3.81	27	1.5/1
10....	97.6	2	..	..	.4	3.28	37	5/1
11....	97.3	2	..	..	.7	3.41	34	3/1
12....	96.75	2	..	..	1.25	3.68	29	1.6/1
13....	96	2	..	..	2	4.0	23	1/1
14....	95	2	..	..	3	3.95	24	.66/1
15....	100	..	..	..	..	3.13	40	..

The references cited by the Patent Office were two patents to Field, Nos. 2,271,362 and 2,271,364 both dated Jan. 27, 1942.

Sealing Electron Discharge Devices. Fig. 4. Patent No. 2,499,854. (One sheet of drawings.) This invention by Bennett S. Ellefson of Bayside, N. Y., was assigned to Sylvania Electric Products Inc.

The method involves the use of a single-turn helix of soft glass which may well be formed in accordance with a co-pending application divided from Ellefson's Patent No. 2,342,609. Fig. 4 shows a mount 10 of an electron discharge tube having metal terminals 12 sealed in a glass header 14. This header is to be sealed to a bulb 18. Between these two parts, there is placed a single-turn glass helix 22 made from glass having a low melting point. The parts while so assembled are rotated while being heated by a flame 20 and after the ring has been softened, the parts are moved together thus forming a seal. The helical form of the ring 22 provides means for making a better seal than would be possible if the ring were in the form of an annulus.

References cited by the Patent Office were Vello, No. 1,861,167 dated May 31, 1932 and Thomas, No. 2,131,923 dated Oct. 4, 1938.

Glass Bending Machine. Fig. 5. Patent No. 2,500,278. (2 sheets of drawings.) Donald W. Dunipace assigned this invention to Libbey-Owens-Ford Glass Company. The machine bends the glass without the use of molds thereby producing a more nearly perfect curved sheet.

The machine comprises a carriage 10 carrying a pair of horizontal cylinders 11 and 12 each having a holder 13 and 14, respectively, which support a glass sheet 15 to be bent. The cylinders are supported at opposite ends by cables 23 and 24 which wrap around the cylinders. Other cables 32 wrap around the cylinders in the opposite direction and their lower ends are attached to weights 36.

In operation, the sheet 15 to be bent is first supported between the holders 13 and 14 as shown in full lines. The glass sheet prevents the cylinders from turning until the carriage has been moved into a heating oven. When the glass has become softened, the weights cause the cylinders to turn while the glass assumes the position shown in dotted lines without the use of molds of any kind. The bending operation is stopped by cables 44 and 45 which can be adjusted in length. Certain variations in the method of operation are described in the patent.

The following references are of record in the file of this patent: United States Patents: 760,959, Connington, May, 24, 1904; 1,999,558, Black, Apr. 30, 1935; and 2,330,349, Galey, Sept. 28, 1943.

Ampul Sealing Machine. Fig. 6. Patent No. 2,500,521. (3 sheets of drawings.) This is an invention by Frank

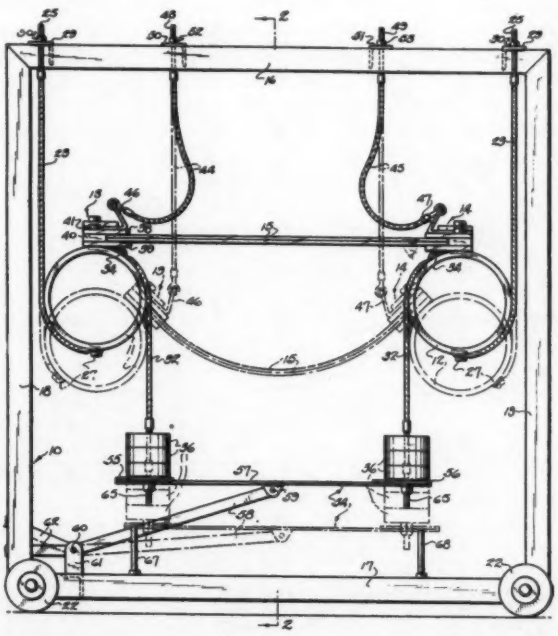


Fig. 5. Glass Bending Machine.

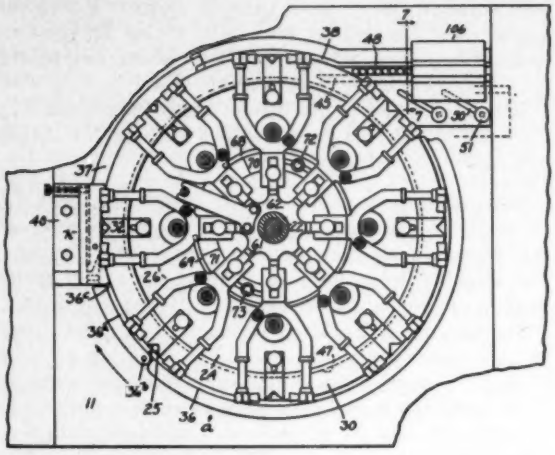


Fig. 6. Ampul Sealing Machine.

J. Cozzoli of Plainfield, N. J., and in some respects it is an improvement over the machines shown in his patents No. 2,258,408 and 2,379,343.

The machine comprises a rotating table 24 carrying 8 receptacles 25 and burners 26. The upper and lower ends of the tubes to be sealed are engaged by grippers and when the glass has been softened by burners the tube is stretched slightly to form a constricted neck. This is allowed to cool slightly, again heated and stretched. Further heat is applied and as the constricted neck starts to close, the ends of the tube are moved apart while the flame seals the small remaining opening. The patent gives full directions for the construction and operation of the machine.

The following references are of record in the file of this patent: United States Patents: 1,844,869, Hauger et al., Feb. 9, 1932; 1,862,821, Henderson, June 14, 1932; 1,962,985, Dichter, June 12, 1934; 2,258,408, Cozzoli, Oct. 7, 1941; and 2,282,993, Dichter, May 12, 1942. Foreign Patents: 637,943, Germany, Nov. 6, 1936.

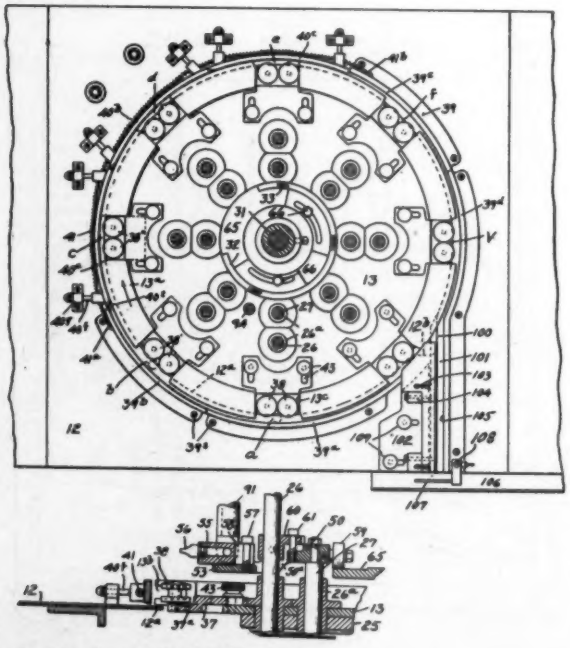


Fig. 7. Ampul Sealing Machine.

Ampul Sealing Machine. Fig. 7. Patent No. 2,500,522. (2 sheets of drawings.) This is another machine for sealing ampuls or other glass tubes by the same inventor, Frank J. Cozzoli, as in the preceding patent.

A revolving carrier 13 is provided with 8 sets of rolls 38 which support the unsealed ampuls placed there between the points marked a and b. When an ampul reaches a yielding section 40a, it is rotated by the frictional engagement therewith and, at the same time, a burner is lowered to soften the glass. At about point d, grippers are lowered to engage the upper end of the tube and to lift it, drawing out a neck and then sealing it.

The sealed ampul then cools as it is carried to the discharge device 100 from which it may be prepared for shipment.

The following references are of record in the file of this patent: United States Patents: 1,862,821, Henderson, June 14, 1932; 2,209,252, Stewart et al., July 23, 1940; 2,258,408, Cozzoli, Oct. 7, 1941; 2,282,993, Dichter, May 12, 1942; and 2,379,343, Cozzoli, June 26, 1945. Foreign Patents: 671,056, Germany, Jan. 30, 1939.

Ampul Severing Machine. Patent No. 2,494,674. (6 sheets of drawings.) This invention by A. R. Smith, G. A. Lee and C. J. Hopkins, all residents of England, relates to a machine for cutting off the necks of ampuls before they are filled and sealed. A corresponding application has been filed in Great Britain and this U. S. patent will expire Dec. 14, 1964.

The machine comprises a horizontal track along which the ampuls are moved, a scoring wheel which is engaged by the ampuls while they are being rotated so as to define the point of severance, and means for knocking off the waste part of the ampul so as to prepare it for the filling and sealing operation.

The description and drawings (not reproduced here) give full information for the operation of the machine and making the necessary adjustments to accommodate ampuls of varying sizes.

The following references are of record in the file of this patent: United States Patents: 2,112,118, Rowe, Mar. 22, 1938; 2,258,408, Cozzoli, Oct. 7, 1941; and 2,362,115, Cline, Nov. 7, 1944.

Glass Perforating Machine. Fig. 8. Patent No. 2,495,971. (One sheet of drawings.) This machine or tool was invented by John F. Iselin of Indianapolis, Ind. The tool is said to make a clean hole in glass tile very rapidly without taking the time or running the risk of breakage incurred by the use of the usual drilling operation.

The device consists of a flat base which is placed upon the tile to be perforated, this base having a spring actuated lever 16 carrying a punch 24 at the outer end. This lever is turned back by hand as shown and when released, snaps over and punches a clean hole in the glass. Larger holes are made by punching a row of the small holes.

The following references are of record in the file of this patent: United States Patents: 254,090, Carr, Feb. 21, 1882; 347,742, Rylands, Aug. 17, 1886; 458,381,

(*Continued on page* 212)

CONGRESSIONAL LABOR COMMITTEE TAKES NOTE

A subcommittee of the House Labor Committee is expected soon to begin an investigation of the effect of low-priced imports on employment. This is a clear indication that the new National Labor-Management Council on Foreign Trade Policy is getting somewhere in its campaign to bring some protection to those industries which really are hard-pressed by reductions in U. S. tariffs. This move is of particular importance because later this year the State Department will negotiate a third round—the third since the end of the war—of multilateral tariff reductions. Incidentally, action is scheduled on tariffs of various glass products. Furthermore, there is now pending in Congress a move to approve the charter of the International Trade Organization, and this approval if forthcoming without limitations would mean that tariff reductions already negotiated with a comparatively few nations would be extended automatically to 73 nations.

An increasing number of members of Congress are becoming impressed with the efforts of the Council on Foreign Trade Policy. In its statement of principles, laid down March 21, the Council said that, "contrary to the theory of classical economists and free trade advocates, the competitive advantages of imported dutiable goods in our domestic market are not generally reducible to superiority of natural resources, soil, climate, or greater efficiency in the countries of origin. Unfortunately they are attributable in some cases to simple exploitation of labor. Competitive goods that derive their cheapness from this source therefore enter higher-standard countries with a spurious economic advantage rather than a fair one.

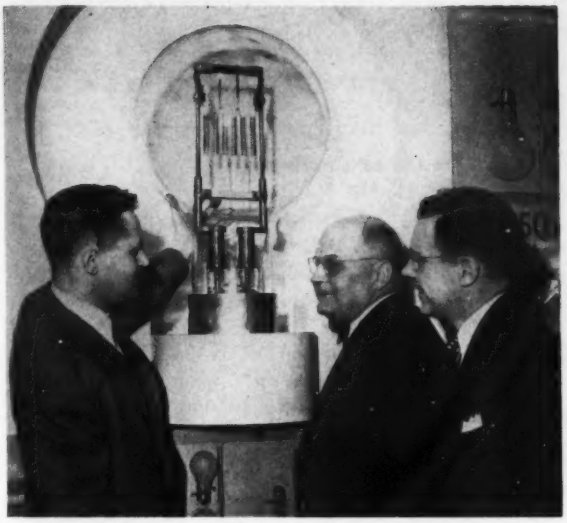
"Protective measures that are designed simply to place competitive foreign products on a fair competitive level in the market of a high-standard country can not properly be described as trade barriers or obstacles to the flow of healthy trade. About 60 per cent of our imports, now free of duty, are largely non-competitive products and raw materials. But the claim of consumers to the enjoyment of lower prices on the remaining 40 per cent of our imports, which are competitive goods, is not valid if the lower prices of the latter merely reflect lower wage levels abroad, since such a claim would be based on the destruction of our economic standards.

"Any legitimate industry in the United States that pays prevailing wages and is able to market its products at prices returning a reasonable profit under fair competitive conditions and succeeds in setting aside reserves for research and development, is not only economically justified but is entitled to protection. The degree of protection should be roughly equal to the advantage of foreign producers in this market as a result of their lower labor standards, modified by relative productivity."

C. B. BELKNAP ADDED TO BOARD OF ARTHUR C. LITTLE, INC.

Charles B. Belknap, research consultant for Owens-Illinois Glass Company, has been elected to the directorate of Arthur C. Little, Inc.

Mr. Belknap was executive vice president of Owens-Illinois from 1933 to 1941 after which he has served as vice chairman of the board and co-ordinator of research.



G-E HOLDS ILLUMINATING GLASSWARE MEETING

At a one-day meeting of the Illuminating Glassware Manufacturers at Nela Park, Ohio, the importance of glass in the manufacturing of modern electric lamps was emphasized by discussions on that subject.

Viewing the biggest of all incandescent lamps, a 50,000-watter, in the "lamp gallery" of General Electric Company's Lighting Institute are, left to right above, R. W. Morris, Lighting Engineer for G-E Lamp Department; H. L. Dillingham of the Illuminating Glassware Division of the American Glassware Association; and Arthur Tylor, Manager of lighting sales for Corning Glass Works and also a member of the American Glassware Association.

About 25 members of the Illuminating Glassware Manufacturers met with G-E engineers for the one-day meeting. Subjects discussed were the status of illuminating glassware in a modern lighting practice, new light sources, photometry, production standardization and G-E's new Lighting Clinic.

Mr. Tylor served as Chairman of the day's meeting and Mr. Dillingham as Secretary. Mr. Morris is acting as liaison representative for both the American Glassware Association and G-E's Lamp Department.

FIBERGLAS MOVES EXPORT DIVISION

Keith O. Grove has been appointed Manager of the Export Division of Owens-Corning Fiberglas Corp., which is being moved from the general offices in Toledo to New York City, it has been announced.

Mr. Grove succeeds Gerard dePiolenc, who has been named assistant director of research at the company's research and engineering laboratories.

Removal of the export division office to New York is expected to bring more effective sales results since New York is the center of export trade and the headquarters of many large engineering firms engaged in construction overseas, it was pointed out.

Mr. Grove joined Owens-Corning in 1942 and held administrative posts in the service department and pricing division before transferring to the export division in 1947.

Research Digest

The Economics of Cooling Glass Tanks by Air

The general consensus of opinion in the industry is that tank block life is considerably increased by air-cooling and thus a greater production obtained per tank life. It is often tacitly assumed that this must inevitably result in financial advantage. C. E. Gould (*Journal of the Society of Glass Technology*, April 1949) shows that such financial advantage follows only when the increase in life exceeds a certain value. In addition, Gould has worked out a series of general formulae which enable the profit and loss account for air cooling to be calculated in any particular case.

The development of these formulae is as follows:

F = annual cost of fuel and other charges which operate only when the tank is running (annual cost means cost which would apply if the furnace continuously operated for 52 weeks). These charges include coal, oil, steam, electricity (apart from air-cooling), water, batch materials, maintenance, consumable stores, labor.

D = Annual amount of costs which operate whether the furnace is running or not. These include depreciation, rent, rates, taxes (some labor), general overheads.

S = Salable value of product per annum, assuming 52 weeks continuous production.

N = Number of repairs per annum (this may be a fraction).

n = Fraction of year occupied by each repair.

C = Cost of each repair.

L = Time between repairs in years.

Then: Total time lost in repairs per annum $= nN$

Actual salable value per annum $= S(1-nN)$

Running costs per annum $= F(1-nN)+D+NC$

Annual profit from furnace without cooling =

$$S(1-nN)-F(1-nN)-D-NC$$

$$S-F-D-nN(S-F)-NC \quad . \quad (1)$$

Now suppose that air-cooling is applied and that the life between repairs is increased from L to $L(1+x)$.

With no cooling N = number of repairs per annum $= \dfrac{1}{L+n}$

With cooling N' = number of repairs per annum $= \dfrac{1}{L(1+x)+n}$

$$= \frac{N}{1+x(1-nN)}$$

K = Capital cost of cooling equipment.

y = Fraction of capital cost of air-cooling allocated to maintenance, depreciation and interest.

p = Annual cost of running cooling equipment.

Then, for the air-cooled tank:

Total time lost in repairs per annum $= nN' = \dfrac{nN}{1+x(1-nN)}$

Actual salable value per annum $= S\left(1-\dfrac{nN}{1+x(1-nN)}\right)$

Cost of repairs $= \dfrac{NC}{1+x(1-nN)}$

Cost of cooling $= Ky+p\left(1-\dfrac{nN}{1+x(1-nN)}\right)$

Operating costs $= F\left(1-\dfrac{nN}{1+x(1-nN)}\right)+D$

And the annual profit from the air-cooled tank:

$$= S\left(1-\frac{nN}{1+x(1-nN)}\right)-F\left(1-\frac{nN}{1+x(1-nN)}\right)$$

$$-D-\frac{NC}{1+x(1-nN)}-Ky-p\left(1-\frac{nN}{1+x(1-nN)}\right) \quad (2)$$

For air-cooling to show a saving the value of x must be such that (2) is greater than (1), *i.e.*, the value of x must be greater than that which will make the quantity (2) = the quantity (1).

Putting (2) = (1) and solving for x we get:

$$x = \frac{Ky+p(1-nN)}{(1-nN)(nN(S-F)+NC-Ky-p)} \quad . \quad . \quad (3)$$

As these developed equations are difficult to examine in general terms, an attempt was made to substitute plausible values for the various symbols and then to explore the effect of variations in some of the factors. (Editor's Note: In the examples that follow, English pounds have been changed to dollars by multiplying by a factor of 4 in order to bring the numerical value in line with American dollars.)

Example 1:

Take S = \$2,600,000 per annum
F = 1,680,000 " "
D = 300,000 " "
C = 28,000 per repair
K = 8,000
p = 8,000 per annum
y = 0.10, i.e., depreciation at 10% per annum.
n = 0.10, i.e., repair takes 5¼ weeks.

The main variable is N, the number of repairs per annum related to the life L by the expression:

$$L = \frac{1}{N} - n$$

The annual profit from equation (1) and the value of x from equation (3) have been worked out for values of N from 0 to 2.0 corresponding to length of operating time from infinity to about 5 months with the following results:

N	L (years)	Profit (Eq. 1)	Value of x (%)
0	——	$ 620,000	——
0.3	3.23	584,000	32.4
0.6	1.57	548,000	14.0
1.0	0.90	500,000	8.0
1.5	0.57	440,000	5.2
2.0	0.40	380,000	3.9

Thus, the shorter the life of the uncooled tank, the smaller the increase of life which air-cooling must provide to make its application profitable. If the life of the uncooled tank is about one year, which may be taken as a usual case, air-cooling must produce at least an 8 percent increase of life to be profitable in the particular case examined.

Example 2:

If the tank is less profitable due to a lower selling price, and S is reduced to $2,200,000, the corresponding figures become:

N	Profit	x (%)
0	$ 220,000	——
0.3	196,000	58.1
0.6	172,000	22.6
1.0	140,000	12.5
1.5	100,000	8.0
2.0	60,000	6.0

This table shows a similar decrease in x as N increases to that of Example 1, but emphasizes that as the profitability decreases, air-cooling must show a greater increase of life to be worthwhile. Where N is 1.0, the following table shows how x varies with the profit:

S	Profit (Eq. 1)	x (%)
$ 2,600,000	$ 500,000	8.0
2,440,000	356,000	9.3
2,320,000	248,000	10.7
2,200,000	140,000	12.5
2,080,000	32,000	15.0
2,060,000	14,000	15.5
2,048,000	3,200	15.9

Example 3:

Equation (2) can be used to calculate the extra profit earned by air-cooling if the increase of life is known. In Example (2) where S is $2,200,000 and assuming N is 1.0, then the profit varies with x as follows:

x (%)	Life (years)	Profit/Annum	Increase of Profit Due to Cooling
0	0.90	$ 140,000	——
5	0.945	135,400	—4600
10	0.990	138,920	—1080
15	1.035	141,424	+1424
20	1.08	144,056	+4056
25	1.125	146,564	+6564
30	1.17	148,856	+8856
40	1.26	152,980	+12,980
50	1.35	156,560	+16,560

The most striking feature of this table is the comparatively small increase of profit which follows even very considerable increase of life. Of course, in cases where the inherent profitability is greater, i.e., for larger values of S, the increase of profit with life will be more marked.

Example 4:

It is obvious that there is a relation between the increase of life obtained by air-cooling and the degree of cooling applied. The following table shows the relation between the power expended on cooling and the increase of life which must be obtained to show a profit. The capital cost of the cooling equipment has been assumed to vary (in the way shown in the table) with the annual expenditure on power. S is taken as $2,600,000 and N as 1.0.

Annual cost of power for cooling (p)	Capital cost of Equipment (K)	x (%)
$ 4,000	$ 6,000	4.0
6,000	7,000	6.0
8,000	8,000	8.0
10,000	9,000	10.0
12,000	10,000	12.3
14,000	11,000	14.5
16,000	12,000	16.9

Example 5:

The increase of life which must be obtained for cooling to show a profit varies with the time taken to effect a repair, in the way shown below. S is $2,600,000 and N is 1.0.

Repair Time (Wks. approx.)	n	x (%)
4	0.08	9.6
5¼	0.10	8.0
6¼	0.12	6.9
7¼	0.14	6.0
8¼	0.16	5.4
9¼	0.18	4.9
10½	0.20	4.4

These various examples show that 1) a quite substantial increase in block life must be achieved to make cooling profitable; 2) the greater the margin of profit, the more likely is air-cooling to be profitable; 3) when block life is short, i.e., due to high temperatures or corrosive batch, the relative increase of life to make cooling profitable is smaller; 4) cooling becomes progressively less profitable, other things being equal, as the repair time is reduced.

INNIS, SPEIDEN DIRECTOR RETIRES

Thomas G. Flavelle, Director and Assistant Secretary of Innis, Speiden & Company has retired from active management under the retirement policy of the company. Mr. Flavelle will continue to serve in an advisory capacity and as a Director of the company.

AMERICAN CAPITAL SOUGHT FOR FOREIGN PLANTS

Opportunities offered American manufacturers of glass products to invest in foreign plants seem to be increasing.

The most recent offer forwarded to the Commerce Department is from the Sheet Metal Industries, North Circular Road, Tralee, County Kerry, Ireland. This manufacturer of sheet metal wants to interest some American firm in participating in the establishment of a glass or glass products plant to utilize the sand and other raw materials reportedly available in quantity in Ireland. The Irish firm would furnish 50,000 pounds to help finance the project (current rate of exchange, $2.80), and would expect the American participant to provide the complete plant, and a managing director or the minimum number of trained personnel required to train local labor. The American firm would also be required to take a financial interest in the project.

Another recent offer was from J. M. J. A. Muninghof, Voorburg, Netherlands, who offers property for factory premises, together with adjacent land, all valued at $263,000, as his share of a venture in establishing a glass container plant. Since foreign participation in a Netherlands enterprise is limited to 49 per cent of the total, the American participant's investment would be limited to $260,000. For this he would be expected to furnish new fully automatic bottle-making machinery and refractory materials, and patents. Mr. Muninghof, perhaps realizing that his $263,000 of land, comprising 25,000 acres, might not balance the proposed American investment because only part of it could be of value, would consider other arrangements. His address is 125 Laan van Nieuwe Oost Einde, Voorburg, Netherlands.

Aaron Weisburg, representing Phoenicia Glass Works, 2 Jaffa-Tel-Aviv Road, Tel-Aviv, Israel, is in this country to purchase equipment for glass furnaces and electrical equipment for rolling mills. His address here is Palestine Purchasing Services, 386 Fourth Avenue, New York, N. Y.

EDMUND BALL RE-ELECTED PRESIDENT OF BALL BROS.

The re-election of Edmund F. Ball as President of the Ball Brothers Company has been announced by the Board of Directors following its recent annual meeting. G. A. Ball, President of the firm until he relinquished that office in 1948 and one of the five founding Ball brothers, was renamed Chairman of the Board.

The annual meeting also brought the elevation of John W. Fisher to a vice presidency and the election of A. M. Bracken, Vice President and General Counsel, to serve in the added capacity of Secretary. Mr. Fisher will continue to be in charge of production in all glass container, paper, zinc and rubber plants.

The Directors also re-elected William H. Ball to the vice presidency he has held for several years and chose George E. Myers to continue as the company's Treasurer. Mr. Myers was also assigned the further duties of serving as assistant secretary.

• Dr. John H. Lux has been appointed Manager of the New Product Development Laboratory of the General Electric Company chemical department, according to an announcement by Dr. C. E. Reed, engineering manager.

KAHLE ENGINEERING ACTS TO OPPOSE TELEVISION TAX AND FREEZE

Kahle Engineering Company, manufacturer of equipment for the production of electronic tubes, incandescent lamps, etc., in a letter to the Senators and Representatives of the State of New Jersey where the firm is located, urged these legislators to oppose the threats of the imposition of special taxes on the sale of television receivers and parts and the "freeze" on television's geographical expansion.

In addition to stressing the economic danger to the television industry by the passage of such legislation, Kahle's letter also brought to attention the interests of the consumer public and the benefits which they derive from the medium of television. The letter went on to state that the special tax and "freeze" are seen as a menace to the growth and development of television service, better programs, greater enlightenment, finer artistic achievements and a better acquaintance with the leaders of our country.

The passage of these two proposals, of course, will be felt in the glass industry where the manufacture of television tubes is playing an increasingly important part. Such legislation would undoubtedly lower production in this segment of the industry where television tube manufacture is on the upswing.

N. S. C. WALSH DIES

As this issue of THE GLASS INDUSTRY was going to press, word was received of the death of N. S. C. Walsh. Mr. Walsh was Honorary Board Chairman of Walsh Refractories Corporation and a Director of Mississippi Glass Company.

NEW TYPE INDUSTRIAL GLASS PIPE BEING PRODUCED BY CORNING

Corning Glass Works recently began shipments of a new type of industrial glass pipe which is to be known as Pyrex brand Double Tough Glass Pipe.

While it is claimed to be "interchangeable with the quality glass piping we have been shipping", according to a Corning spokesman, the new product is even better. In addition to retaining all the advantages of the present glass piping, it boasts several important new features. These, it is stated, include heat strengthening of all standard fittings, except "U-bends", and of all straight lengths; fifty per cent closer tolerance on length, flatness, angularity and bow.

Despite these featured improvements, the company states that there will be no increase in price of the new glass pipe.

F. G. SCHWALBE ADDRESSES A.C.S. SECTION

Franz G. Schwalbe, Secretary and Chief of design of the Toledo Engineering Co., was guest speaker at a recent dinner meeting of the Northwestern Ohio Section, American Ceramic Society.

Mr. Schwalbe, who has been with Toledo Engineering since 1925, discussed "Problems of Designing for Good Combustion".

Section officers for the new year were elected and movies taken at previous meetings shown.

CURRENT STATISTICAL POSITION OF GLASS

Employment and payrolls: During the month of January 1950, employment in the glass industry was 105,700. This is a little more than 1 per cent below the 107,200 adjusted employment figure for December 1949.

Payrolls for January 1950 were a preliminary $26,987,324. This is a decrease of not quite 1 per cent from the December adjusted payroll figure of $27,017,259.

Glass container production, based on figures released by the Bureau of Census, fell off for the month of February 1950 to 7,349,569 gross. This represents a drop of about 7 per cent from the previous month's production of 7,934,499 gross. During February 1949, production was 6,503,125 gross, which is about 13 per cent lower than production for February 1950. Total glass container production at the close of the first two months of 1950 has reached 15,284,068 gross, as compared with 13,891,311 gross produced during the corresponding period in 1949, which represents an increase of 10 per cent for this year over last.

Shipments of glass containers during February 1950 were 6,899,588 gross. During January, shipments were 7,590,133 gross, which is 9 per cent above February. Although shipments for February are below January, they are 12 per cent more than for February 1949 which were 6,148,625 gross. Total shipments thus far in 1950 are 14,489,721 gross. This is about 14½ per cent higher than the 12,629,135 gross shipped during the first two months of 1949.

Stocks on hand at the close of February 1950 were 9,693,904 gross, which is a little higher than the 9,365,383 gross on hand at the close of January 1950 and about the same as the 9,688,722 gross on hand at the close of February 1949.

Automatic tumbler production for February 1950 dropped close to 9 per cent from the previous month's 6,125,243 dozens to reach 5,577,795 dozens. Production during February 1949 was 4,707,281 dozens. Shipments for February, however, rose 11½ per cent and were reported to be 5,551,844 dozens. This is an increase over the 4,980,813 dozens shipped during January. During February 1949, shipments were 4,449,961 dozens. Stocks on hand at the close of February 1950, were about the same as the previous month—9,819,907 dozens for February and 9,824,671 dozens for January. At the close of February 1949, stocks on hand were 8,692,742 dozens.

Table, kitchen and household glassware: Manufacturers' sales of machine-made table, kitchen and household glassware jumped 20 per cent for the month of February 1950 to reach 3,178,658 dozens. During January, sales were 2,643,586 dozens. Sales during February 1949 were 3,084,343 dozens. At the close of the 12-month period ending February 1950, manufacturers' sales were 39,037,183 dozens as compared with 40,843,740 dozens sold during the corresponding month of 1949. This is a difference of about 4 per cent.

GLASS CONTAINER SHIPMENTS

(All figures in Gross)

	February 1950
Narrow Neck Containers	
Foods	668,405
Medicinal & Health Supplies	971,824
Chemicals, Household & Industrial	547,442
Beverages, Returnable & Non-returnable	289,866
Beer, Returnable	100,646
Beer, Non-returnable	161,942
Liquors	500,417
Wines	274,860
Toiletries & Cosmetics	438,629
Sub-total (Narrow)	3,954,031
Wide Mouth Containers	
Foods	1,847,279
Dairy Products	253,063
Home Canning	*18,626
Medicinal & Health Supplies	257,955
Chemicals, Household & Industrial	121,264
Toiletries & Cosmetics	137,695
Packers' Tumblers	110,820
Sub-total (Wide)	2,746,702
Total Domestic	6,700,733
Export Shipments	198,855
Total Shipments	6,899,588

* This figure represents Fruit Jars only.

GLASS CONTAINER PRODUCTION AND INVENTORY

(All figures in Gross)

		Production February 1950	Stocks February 1950
Foods; Medicinal & Health Supplies; Chemicals, Household & Industrial; Toiletries and Cosmetics	Narrow Neck	2,820,434	3,406,663
	Wide Mouth	2,493,870	2,423,437
Dairy Products		284,713	334,968
Home Canning		*130,720	666,647
Beverages, Returnable		†430,974	836,913
Beverages, Non-returnable		.....	8,014
Beer, Returnable		143,088	557,913
Beer, Non-returnable		159,053	314,882
Liquors		465,216	698,156
Wines		293,323	339,067
Packers' Tumblers		128,178	107,244
Total		7,349,569	9,693,904

* This figure represents Fruit Jars only.
† This figure includes Beverages, Non-returnable.

A. C. S. STUDENT BRANCH TO PUBLISH YEARBOOK

Plans for the revival of the annual "Illini Ceramist" are now underway, according to an announcement by the Student Branch of the American Ceramic Society at the University of Illinois. It is expected that the yearbook will be ready for sale in May.

As in the past, the Illini Ceramist will contain photographs of the graduating seniors, scenes from the student activities and familiar shots of the Ceramics Building. A section devoted to news of the alumni is planned.

SUBSIDIARY DISSOLVED BY LIBBEY-OWENS-FORD

The American Bicheroux Co., a wholly-owned subsidiary of Libbey-Owens-Ford Glass Co., has been dissolved and the patents held by the company dedicated to the use of the people of the United States, L-O-F's annual report to shareholders reveals.

The Bicheroux process for intermittent rolling of plate glass blanks was brought to the United States in 1928. L-O-F's asset values were increased in the amount of $99,000 as a result of the subsidiary's dissolution, the report said.

Also during 1949 the company sold its minority stock interests in Boussois and Franco-Belge, two French glass manufacturing companies, and in Canadian Libbey-Owens Sheet Glass Co.

The European holdings were written off the books in 1941 but the companies survived the war and as a result of the sale a non-recurring income of $300,000 was achieved, the report added.

CAMBRIDGE WIRE CLOTH HOLDS SALES CONFERENCE

The annual Sales Conference of The Cambridge Wire Cloth Company was held for one week recently at the company's home office at Cambridge, Maryland.

The sessions featured the introduction of new products and discussions of existing installations. Greatest emphasis of the Conference was placed on the company's wire cloth and wire fabrication facilities which have recently been expanded to provide better service.

CORNING TO CONSTRUCT TELEVISION BULB PLANT

A new glass plant, to be constructed in Albion, Michigan, for the manufacture of glass bulbs for television picture tubes, has been announced by William C. Decker, President of Corning Glass Works.

The plant, which will have a floor area of more than 300,000 square feet, will be erected on a thirty-one acre site and construction is now underway. Mr. Decker stated that the plant is being built to provide additional manufacturing capacity for television glass requirements. Albion, Michigan, was selected for the site because a substantial part of the television industry is located in the middle west. The new plant is scheduled to be in production by Fall and initial employment is expected to be approximately 600 men and women.

HOBBS TO EXPAND MIRROR FACILITIES

Hobbs Glass Limited has announced plans to expand its mirror operations by the erection of a $300,000 addition to its plant in London, Ontario. The new building is to contain machinery of the latest design for fabrication of mirrors and will enable the company to expand production considerably.

Tenders have already been called and completion is scheduled for the beginning of August. The enlarged plant will result in the employment of a considerably increased working staff.

The company has also announced that F. W. P. Jones, formerly in charge of sales, has assumed the position of General Manager.

BORAX

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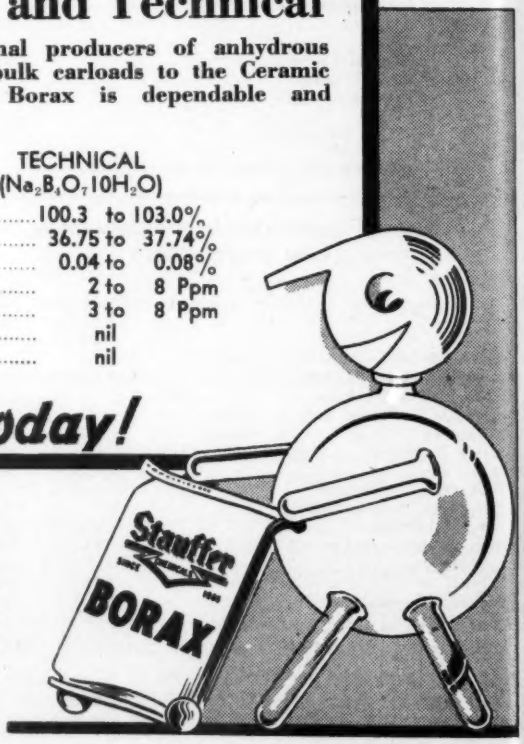
TYPICAL ANALYSIS	ANHYDROUS ($Na_2B_4O_7$)	TECHNICAL ($Na_2B_4O_7 10H_2O$)
Sodium Borate	99.25 to 99.50%	100.3 to 103.0%
Boron as B_2O_3	68.00 to 68.89%	36.75 to 37.74%
Chlorides as NaCl	0.10 to 0.16%	0.04 to 0.08%
Iron as Fe	30 to 35 Ppm	2 to 8 Ppm
Arsenic as As_2O_3	20 to 40 Ppm	3 to 8 Ppm
Sulphates as Na_2SO_4	0.3 to 0.4%	nil
Carbonates as Na_2CO_3	nil	nil



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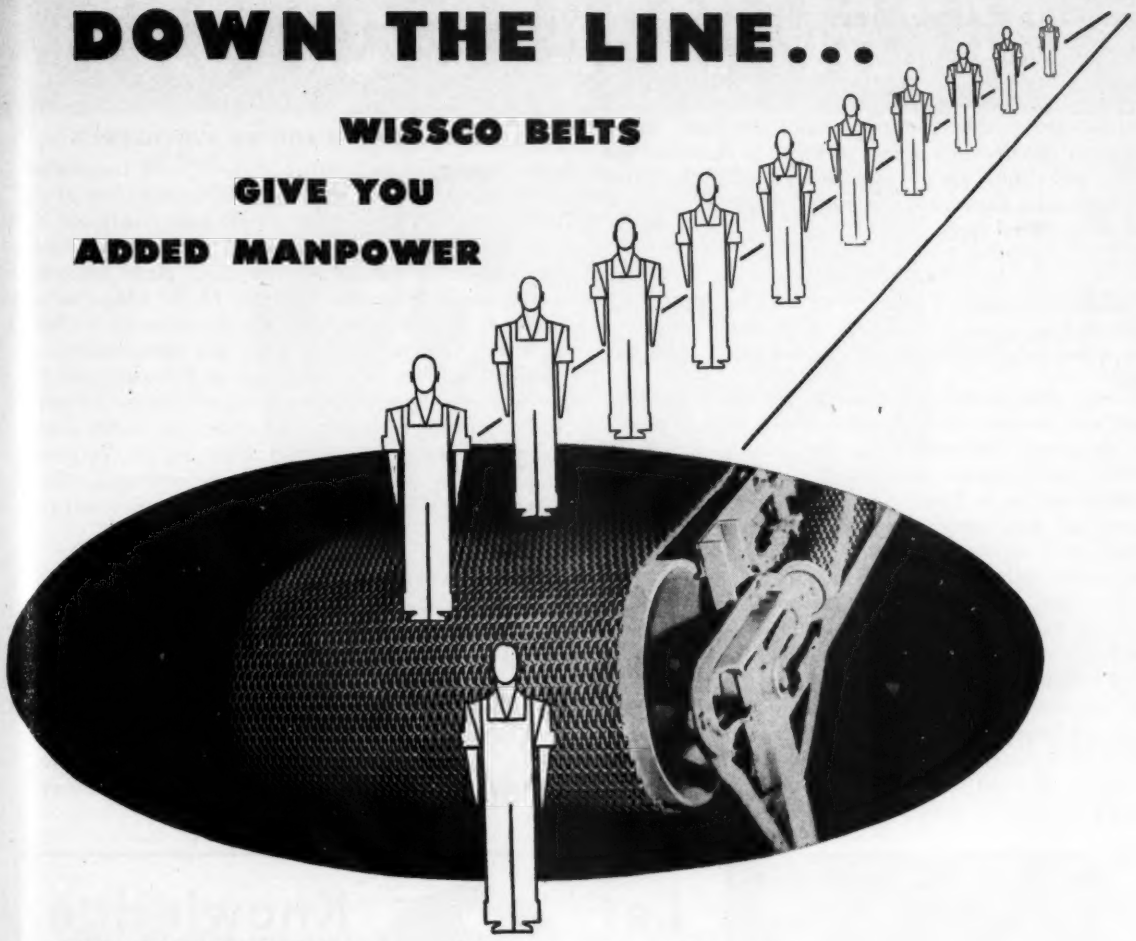

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***Pacific Coast Subsidiary*—The California Wire Cloth Corp., Oakland 6, California**

NEW TARIFF COMMITTEE . . .

(*Continued from page* 191)

In the container classification, in 1948 vials and ampuls were considered pharmaceutical products. In the glassware classification, a few products, as chimneys and globes and shades, are not mentioned. For products that are mentioned, figures are direct from the Census Bureau, but not in official form.

Imports

Illuminating articles	$1,705,692	$1,503,352
Table and art glassware	2,384,333	2,940,454
Blown and pressed glassware..	2,380,197	3,906,891

Blown and pressed glassware in this table includes table and art glassware. Imports of flat glass products are not given. They were not available at this writing.

Plate glass exports are holding up well because of building booms in Latin American countries, some of whom say they prefer American products because of quality and delivery. Exports of pharmaceutical and proprietary ware increased because more foreign drug products are being packed in glass. Generally, more foreign carbonated and alcoholic beverages are being produced, but more bottles for these products are now produced locally.

In imports, the table and art glassware classification shows an increase of $556,121. Of this increase, however, $353,488 went to Canada for glass television tubes, or blanks. The net increase in imports of table and art glassware was only about $200,000. Most of the glassware import increases came from Japan, Poland, Hungary, Italy and France. Imports from Sweden decreased.

A.S.T.M. REFRACTORIES COMMITTEE

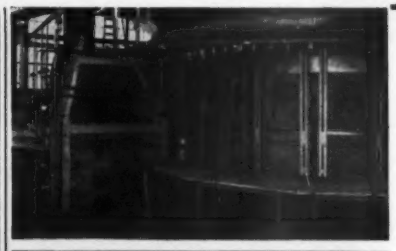
At the Spring Group Meeting of A. S. T. M. Committees in Pittsburgh, Committee C-8 on Refractories met at the Mellon Institute. The present officers were nominated for re-election for the ensuing term. New chairmen of subcommittees were announced with J. J. Hazel assuming the chairmanship of Subcommittee IX on Classification and R. A. Hindel taking over the chairmanship of Subcommittee XIII on Foreign Tests and Specifications.

General activity in all sections of Subcommittee III on Tests was reported. Two new definitions covering carbon refractories and carbon ceramic refractories, respectively, were accepted for letter ballot. A special group was appointed to clarify some confusion which exists as to what constitutes definitions, specifications and classifications.

R. R. SHIVELY, JR. RECEIVES DEGREE

Robert R. Shively, Jr., who graduated from Lehigh University prior to entering the army in World War II, received his Ph.D degree in Ceramics from Pennsylvania State College, it has been announced. He has accepted a position with the Zenith Radio Corporation in Chicago.

• The Cambridge Wire Cloth Company has announced the assignment of J. C. Peters to the New England territory.



Illustrated here are three typical TECO installations, each to meet a specific requirement or problem.

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Over 34,000,000 Bottles

decorated with Duro-Glo Colors since their introduction less than a year ago!

Duro-Glo offers lower maturity—1000° F; longer firing range—approximately 200° F; and greater stability than any other colors ever developed for screen application on glass containers!

Ever since their introduction, "Duro-Glo" Glass Colors have enjoyed outstanding acceptance by the trade. Actual performance results prove "Duro-Glo" to be the finest colors ever developed for squeegee application on commercial glasses.

Many of the country's leading container manufacturers have found these superior glass colors provide the answer to their requirements for superior ware with more eye appeal and fewer rejects.

Not affected by normal lehr temperature fluctuations, "Duro-Glo" Colors may be safely applied and fired at both the low and high temperature limits without blistering of color, deformation of glass or chain marks.

They give an extremely stable color with a high gloss and opacity never before provided by colors of this type. Why not let us demonstrate what "Duro-Glo" Colors can do for your ware!

YOU CAN ALWAYS RELY ON

FOR POTTERY, GLASS, PORCELAIN ENAMELS

THE VITRO MANUFACTURING CO. CORLISS STATION • PITTSBURGH 4, PA.

CERAMIC COLOR SPECIALISTS FOR OVER 41 YEARS

Sales Representatives Pittsburgh · Chicago · New York · San Francisco · Los Angeles · Chattanooga · Toronto

NEW EQUIPMENT AND SUPPLIES

DRAKOTHERM FOR THERMOPRINTING

B. F. Drakenfeld & Company, Inc., New York, N. Y., has just announced the development of a new and revolutionary screen printing medium for ceramic colors. The product, Drakotherm, is a thermoplastic printing vehicle which entirely eliminates drying between color applications. Squeegee colors prepared in Drakotherm give sharper prints and permit the production of more intricate designs. Applied hot, they harden instantly upon touching the article being decorated and subsequent applications of similarly prepared colors can be applied immediately. The elimination of dryers effects big savings in initial installation costs and operating expenses. There is also a resulting conservation of space and reduction in the temperature of the decorating room.

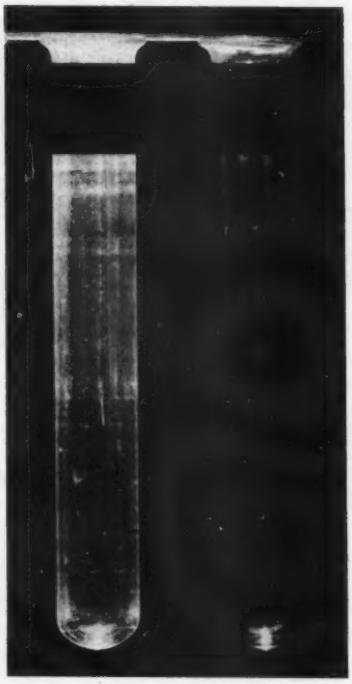
Supplied ready for use, colors in Drakotherm are solid at room temperatures. Application is accomplished by simply heating the prepared color to bring it to a fluid state and applying it to a screen heated by a thermostatically controlled radiant heater. Ambient temperatures do not materially affect the viscosity, and thickness of application is readily controlled. Firing of the printed colors is carried out in the usual manner.

Because colors in Drakotherm don't readily clog screens, shutting down production for washing out is practically eliminated and the number of misprints is greatly reduced. If a misprint should occur due to poor registration, it is easily cleaned by buffing or hot water washing.

Prior to the development of Drakotherm, the squeegee oil process consisted of first preparing the color paint by mixing a dry ceramic enamel powder with an oil vehicle known as squeegee oil. This mixture was usually of the consistency of a very heavy cream. In this heretofore conventional procedure, freshly printed ware would smear if touched in any manner. In order to apply a subsequent color, it was necessary that the ware be passed through a heated tunnel to dry and harden the paint. This was usually done by conveyors slowly carrying the ware for about 45 or 50 feet, passing through a heated tunnel on the way to the next machine. After the second position, the same operation was repeated if a third color was to be applied.

At present, it is estimated that 95% of the industry uses semi-automatic machinery. By eliminating drying between color applications, Drakotherm makes possible the development of completely automatic equipment of simpler design with resulting lower costs and increased production economies.

Owing to special techniques involved in the preparation of Drakotherm-color mixture, the medium, as such, is not presently available. However, colors in Drakotherm may be had in various shades and for most types of screen printing work. Although there have been many improvements in the properties of ceramic colors, thermoprinting with Drakotherm represents the *first major improvement* in technique offered to users of the screen process.



TWO NEW WYANDOTTE DETERGENTS

Wyandotte Chemicals Corporation, Wyandotte, Michigan, has announced the additon of two new detergents to its line of chemicals for use in the laboratory. The test tubes illustrated were immersed for eighteen hours at 210°F. in 0.30% solutions of glass washing detergents. The badly etched tube at the left was exposed to a standard detergent solution; the new-looking tube on the right was immersed in Wyandotte Dural H, an inhibited detergent for safely washing laboratory glassware by hand.

Dural H washes quickly and thoroughly even in hard water, produces little or no etching and dissolves laboratory glassware at rates from 2 to 33 times slower than standard detergents. The second detergent being produced by Wyandotte, Dural M, has been originated for the *machine* washing of laboratory glassware. Both products are well suited for washing culture and test tubes, Petri dishes, Erlenmeyer flasks, centrifuge tubes and laboratory glassware of all kinds.

CONVECTION OVENS

Modern Electric Laboratory, 306 West 69th Street, Chicago 21, Illinois, is producing high temperature electric gravity convection ovens designated as Blue "M" Hi-Heat ovens. The ovens are suitable for production or laboratory work which requires precisely controlled clean dry heat above the average in baking, drying or preheating. The units have uses such as glass annealing, tempering or drawing of non-ferrous parts, carbon steels, etc.

The ovens have double walled housing and 5″ of dual insulation on all six sides. A series of intake ports at the bottom of the oven allow fresh air to enter and be diffused through a perforated diffuser plate. An electric indicating and controlling hydraulic unit automatically maintains the temperature inside the oven. Three series having ranges to 800°F., 1000°F. and 1200°F. are available. A new improved method of spreading Modella heating element over entire width and depth of bottom compartment insures temperature uniformity.

CATALOGUES RECEIVED

Selas Corporation of America, Erie Avenue and D Street, Philadelphia 34, Pa., is distributing a new bulletin describing industrial heat processing techniques with radiant gas burners that beam high temperatures to materials at the speed of light.

The booklet discusses the uses, applications and advantages of the Selas Duradiant Burners and line drawings illustrate some of the features to be found in these burners. Illustrations of installations are also shown and information concerning burner design and construction is included.

Mississippi Glass Company, St. Louis, Mo., has released a new 12-page catalogue detailing how to increase productivity and lower maintenance costs in industrial and other buildings through the use of Coolite, Heat Absorbing and Glare Reducing Glass.

Recommended for new construction, modernization and replacement work, Glare Reducing Coolite is described as a glass that not only reduces the transmission of solar heat radiation, thus decreasing room temperatures, but by controlling daylight illumination, admits only softly diffused working light.

Typical applications in factories and schools are illustrated and important facts covering the heat absorbing and glare reducing properties of the glass, confirmed in experiments conducted by an independent testing laboratory, are presented. In addition to heat and light transmission tables, the catalogue also contains complete specification data. Catalogue and free samples of Coolite glass are available without obligation when requested on company letterhead.

SURFACE COMBUSTION *Serves the* GLASS INDUSTRY

★ Continuous Glass Annealing Lehrs for Every Kind of Glass

★ Continuous Convexing and Bending Furnaces

★ Continuous Decorating or Reannealing Lehrs

★ Continuous Conveyor Type Pottery Decorating Kilns

★ Special Processing Furnaces

★ Mould Heating Ovens

★ Recuperative Glass Melting Tanks

Consulting Engineering Service on All Heating Operations

SURFACE COMBUSTION CORPORATION

TOLEDO 1, OHIO

Q. A. G.

Spelled out, that means *quality amber glass* and you can get it by using Calumite.

In a recent technical paper on the subject, the five qualifications for quality amber glass were listed as follows:

1. **It must work well on machines.**
2. **It must be stable amber free from seeds and blisters.**
3. **It must be an amber color with reddish tints rather than yellow or brown.**
4. **The intensity of amber color must not vary too much from day to day or week to week.**
5. **Melting and batch cost per ton glass must be within reason. These things must be done at the lowest possible cost, which means using raw materials within the freight rate limitation of the producing plant.**

These are the problems which have bothered amber glass manufacturers for years—and they are just the problems that Calumite is overcoming every day in plants where it is used for amber glass. It meets *all* of these requirements —from glass workability to low cost per ton glass. The use of Calumite as *the* amber batch constituent is increasing daily.

Our representative will be available for discussion at the A. C. S. New York Meeting.

The Calumite Co.
HAMILTON, OHIO

INVENTIONS AND INVENTORS . . .

(*Continued from page* 200)

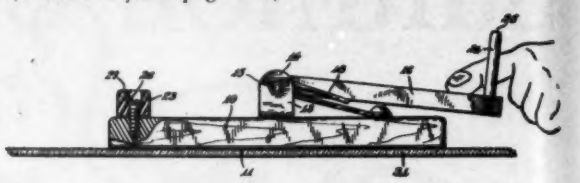


Fig. 8. Glass Perforating Machine.

Watson, Aug. 25, 1891; 810,474, Doane, Jan. 23, 1906; and 813,123, True, Feb. 20, 1906. Foreign Patents: 15,281, Great Britain, No. 20, 1884, and 10,815, France, Oct. 27, 1854.

General Electric Glass-to-Metal Sealing Machine. Fig. 9. Patent No. 2,494,870. (2 sheets of drawings.) Alfred Greiner appears as an inventor in three patents assigned to General Electric Company, all relating to the manufacture of fluorescent lamps or similar articles. The other two patents are reviewed in the March issue of THE GLASS INDUSTRY.

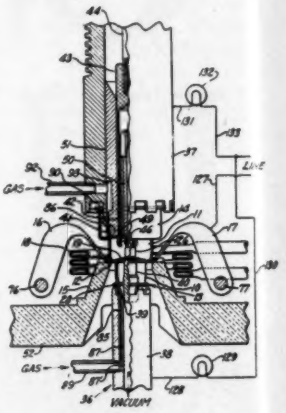


Fig. 9. General Electric Glass-to-Metal Sealing Machine.

A section through the working parts of the machine are shown in the figure. Glass elements 10 and 11 are first sealed to a metal disc 12 and then other metal elements 13 and 14 are sealed to the ends of the glass elements. The machine is provided with means for heating the glass, for making the necessary mechanical movements and for the application of pressure or vacuum when needed.

The following references are of record in the file of this patent: United States Patents: 2,121,627, Donovan et al., June 21, 1938; 2,125,316, Ronci, Aug. 2, 1938; 2,222,093, Swanson, Nov. 19, 1940; 2,290,050, Hinkley et al., July 14, 1942; 2,297,492, Michaelis, Sept. 29, 1942; 2,320,941, Litton, June 1, 1943; 2,335,617, Thomas et al., Nov. 30, 1943; 2,361,517, White et al., Oct. 31, 1944; 2,374,546, Laico, Aug. 24, 1945; 2,376,439, Machlett et al., May 22, 1945; 2,386,820, Spencer, Oct. 16, 1945; 2,411,184, Beggs, Nov. 19, 1946; and 2,415,412, Buchwald et al., Feb. 11, 1947.

AMERICAN POTASH ANNUAL REPORT

American Potash & Chemical Corporation has reported net earnings of $1,791,019 for the year 1949 compared with $1,727,154 during 1948. After allowance for preferred dividend requirements, earnings on the Class A and B stocks amounted to $2.86 a share for 1949 against $2.74 a share in 1948. Sales for last year were $13,692,992 as compared with $14,520,964 for 1948.

NOW! AN UNBEATABLE COMBINATION...

DRAKENFELD COLORS IN NEW

Drakotherm

FOR THERMOPRINTING

THE REVOLUTIONARY NEW DRAKENFELD DEVELOPMENT IN SCREEN PROCESS PRINTING

Drakenfeld Ceramic Colors are now available in Drakotherm, a newly developed thermoplastic medium. They are so processed to make them especially valuable for beverage bottle and table tumbler printing. Actual production line tests have proven that Drakenfeld Colors in Drakotherm eliminate the need for drying equipment. Kept in a fluid state by radiant energy heaters, they look and behave just like a squeegee oil mix. But the similarity stops right there! For, Drakenfeld Colors in Drakotherm harden to a non-tacky surface the very instant they touch the ware . . . don't smear or smudge . . . permit immediate subsequent color applications.

And that's not all! You get continuous production of razor sharp prints with finest detail. They fire down smoothly. You get faster printing . . . screens last longer. There's no waiting for colors to dry or for ware to cool . . . no clogging of screens. Costly time out for washing is practically eliminated. Whatever type of equipment you use, whether it's automatic or semi-automatic, Drakenfeld Colors in Drakotherm can save valuable time and money for *you*.

Drakenfeld

B. F. DRAKENFELD & CO., INC.
45-47 PARK PLACE
NEW YORK 7, N. Y.

MECHANIZATION OF THE GLASS INDUSTRY . . .

(*Continued from page* 190)

Judicial decisions often, perhaps usually, tend to cut down the breadth of claims because claims are often broader than the invention justified. In the case of decisions in gob feeding, the decisions broadened the scope of the patents and the decisions rightly upheld the claims of ownership of Peiler and his associates over their later imitators.

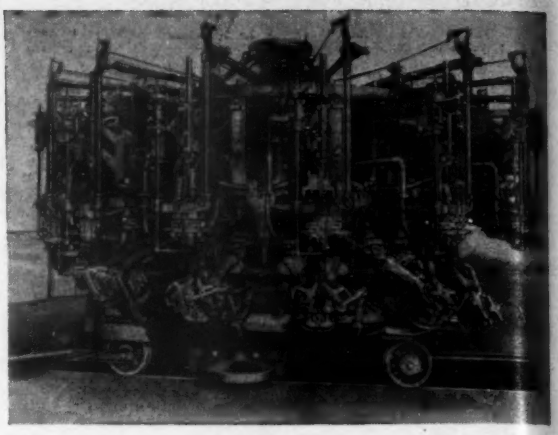
In one case, the appeal to the higher circuit court from an adverse decision against the plaintiff in a lower court charged the lower court with 30 errors. But the higher court not only reversed the decision but interpreted the patents of plaintiff even broader than claimed by plaintiff in the lower court.

Digression

While we have mainly limited our presentation to the establishment of the theme "Efficiency in the Movement of Materials" as the mainspring of economic progress, in plate, window and glass container manufacture, mention is now made of another development, that of electric bulb manufacture, which has been an outstanding addition to our industrial progress. In this case, neither the Arbogast blank system, the Owens suction system, or the gob feeding system were successful because the extreme accuracy and control of the thickness of the bulb wall did not allow even the slightest variation in the desired temperature and viscosity of the bubble which was expanded in a paste mold to form the thin walls of the bulb. All these systems had been tried but were supplanted by a revolutionary machine developed by the Corning Glass Works, variously called the ribbon machine, the chain machine, or the Corning machine.

The diagrammatic sketch shows the essentials of the process. Here a continuous stream of hot glass issued from an orifice and spread over a series of platens forming a chain. An opening in each platen permitted the glass to sag downwardly without contact with any chilling surface. No blank was used and the bubble by gravity, stretching and air controllably introduced into the interior of the depending bubble expanded the bubble to contact the interior wall and the bottom of the paste mold which was rotated to eliminate the mold parting mark which would be present if a stationary mold were used.

This machine proves our theme that "Efficient Movement of Materials" is the key to its success. Using our dollar yardstick, the cost of production of bulbs is substantially less than any other system at present devised. A dollar in cost will move more materials (batch) into a finished bulb. This is interesting also as an example of our "Interpretative Limitations". Comparison with other systems was more than a matter of other things being equal in this case. Although a considerable percentage of the glass fed on the platens is not embodied in the bulb but is returned to the tank for cullet, the finished bulb is superior in quality to those made on the other systems. As a result the pack or percentage of perfect ware is very high, closely approaching 100 per cent, while the bulbs made by the gob fed blank process would average only between 60 and 70 per cent.



Owens 15-arm automatic machine. This machine is capable of producing 350 gross of pint bottles per 24 hours, equivalent to the work of 50 hand operators.

The bulb machine operates at speeds from 300 a minute to a top considerably in excess of 1,000 per minute, the speed depending on the type produced. A proper comparison between a four-man shop producing two bulbs per minute and the Corning Ribbon Machine producing 500 per minute of the same type of bulb would show fairly the reduction in man hours per bulb of over 99 per cent.

The result, contrary to those who claim mechanization reduces employment, was merely to release men to make many other articles for use by the public. Actually more men are employed by the Corning company and the glass industry, their hours of labor shortended, their pay increased, and at the same time the cost of articles made greatly reduced so the public can afford to buy and use a greater number of such articles than before the use of this and similar inventions.

When will labor, particular the unions, learn that mechanization, which they so consistently oppose, is their friend and not their enemy, and only by its use can they and the public generally hope to better their lot with lighter labor, shorter work hours, and more pay which will provide them with more material necessities and luxuries necessary to a higher plane of living.

Apologia

To reduce such a comprehensive subject as mechanization of the glass industry to magazine presentation size necessitated the omission of many angles, developments, credit to inventors, and an unlimited number of important but specific inventions, but which are unnecessary to the validation of the general theme. The notable omission was of the large number of semi-automatic and completely automatic machines both hand fed and feeder fed which enabled the process of Arbogast to become successful commercially. Also the progressive development of the Owens machine from the first six-mold to the largest fifteen-mold unit was most important.

First there was a group of widemouth press and blow machines exactly duplicating the Arbogast disclosure. Then there was another group using a single mold attempting to keep up with the Owens competition, especially on narrow neck bottles and after the inversion of

(*Continued on page* 216)

Ceramics improve with..

ALCOA ALUMINA

Successful ceramic manufacturers use ALCOA Alumina to improve the quality of their products. They know that by adding this uniformly pure, highly inert aluminum oxide to their mixes, they make their products better . . . stronger . . . more resistant to heat and mechanical shock.

These leading companies know, too, that ALCOA Alumina makes ***glass*** sparkle brighter . . . gives ***glazes*** more impact resistance . . . makes ***abrasives*** cut faster . . . increases the electrical resistance of ***porcelain insulators*** . . . And ***refractory*** manufacturers know that even a little ALCOA Alumina makes a whale of a difference in the high-temperature performance of fire brick and other refractory products.

These are just a few of the ways ALCOA Alumina helps make good products *better*. It can do the same for you! We'll gladly furnish you with complete information. Write to ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 613D Gulf Building, Pittsburgh 19, Pennsylvania.

Alcoa Chemicals

ALCOA

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ACTIVATED ALUMINAS • CALCINED ALUMINAS • HYDRATED ALUMINAS • TABULAR ALUMINAS • LOW SODA ALUMINAS ALUMINUM FLUORIDE • SODIUM FLUORIDE • SODIUM ACID FLUORIDE • FLUOBORIC ACID • CRYOLITE • GALLIUM

MECHANIZATION OF THE GLASS INDUSTRY . . .

(*Continued from page* 214)

the blank mold had been invented. Typical of these was the "Johnny Bull" which required two operators, a gatherer, and the machine operator who had to perform over 30 grasshopper-like movements with lightning rapidity.

Next, there developed a series of two table machines, some having four blank molds on one table and five blow molds on the other. Transferring blank and blowing was done by a boy, the gatherer working very fast and another craftsman cutting off the gather and moving the table to next position. Typical of these was the "Jersey Devil" which was pretty generally installed and which greatly reduced the cost of moving molten glass from tank to finished bottle.

The crowding competition of the Owens completely mechanized automatic process motivated the invention of the "No Boy" machine by which everything was done mechanically except the gathering. Typical of this type were "No Boy" machines developed by James Lynch and Frank O'Neill. But still the Owens system in spite of the high cost revolving tank was gradually crowding all but a limited number of firms with Owens licenses out of the picture.

Then the gob feeders developed commercially by Peiler and others associated with him connected with the "No Boy" forming machines, passed the Owens system by eliminating the expensive revolving tank and other features by higher "Efficiency of Movements" of materials from tank to lehr.

The Lynch and O'Neill no-boy machines in a short space of time captured the large part of automatic bottle production. The Lynch no-boy machine probably led all others in total tonnage. Meanwhile, the Owens system increased speeds by using first six-mold machines, then ten-mold machines, and finally the large fifteen-mold machines. Coincidently, multiple cavity molds were developed in the Owens system finally making six bottles per mold for certain small bottles.

The "No Boy" machines were intermittent or "start and stop" types while the Owens was a continuously revolving machine. To meet this, the "No Boy" machines were made in two types: a small unit carrying light molds and high speeds, and the standard carrying heavier molds up to the allowable limit.

Finally the I. S. Machine developed by Henry Ingalls and his associates provided another advance in "Materials Movement Efficiency" and is an example of following the law which is the theme of our text. Except for opening and closing molds mounted on a stationary base, the I. S. Machine moved only the few ounces of glass and that mostly by gravity, instead of starting and stopping and reversing the tons of molds and supporting machinery. The "start and stop" "No Boy" machines were limited to the weight of molds which had to be carried and reversed. This reduced the speed of machines due to the heavy inertia of parts and the lighter molds reduced the "bottles per mold" for lack of sufficient radiation surface. Even the continuously moving "No Boy" machines, of which a limited number were made and are still in use, failed to match the "Movement Efficiency" of the I. S. Machine.

These I. S. units were alike so that a tank could be equipped with machines of two-, four-, six-, or eight-mold units for short, medium or large orders, and thus an even, high-average tank tonnage, so necessary for melting unit efficiency, could be maintained.

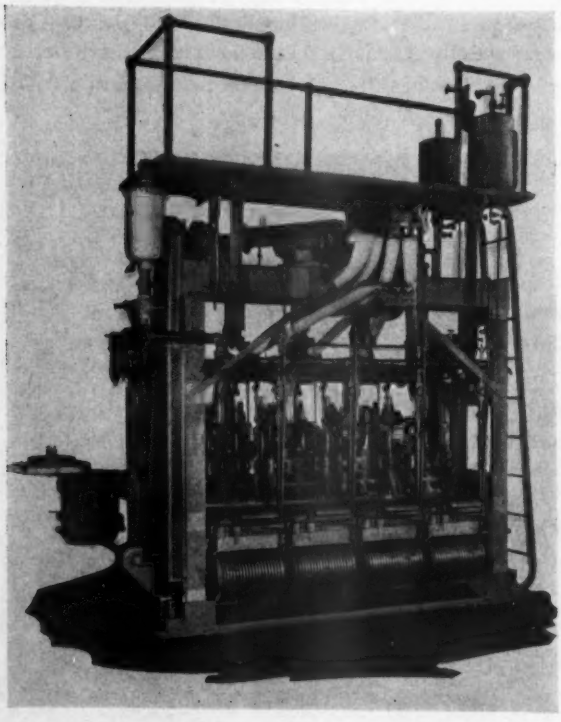
This probably accounts for the fact that although the initial cost per mold is high, the low wear and repair, lower mold cost for short orders, and other advantages permit the payment of royalties over other machine types of lower first cost royalty free.

Summary

The overall picture is the transition of the glass industry in three of its important branches. It showed the important steps in this transition, *what* they were and *how* they were accomplished. It was the story of human action by the hand and brain of man.

There is no attempt to show *why* these various steps

(*Continued on page* 218)



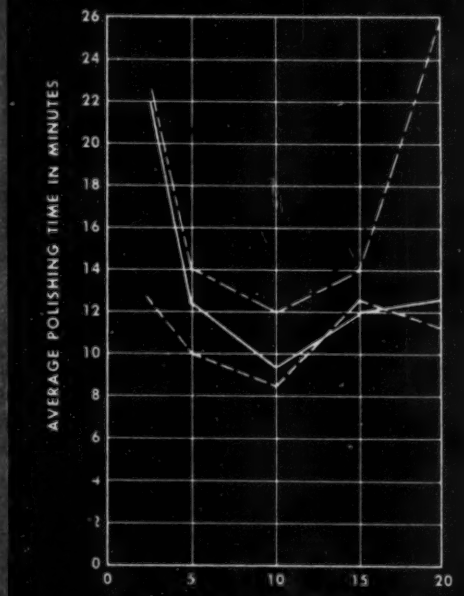
Far left: Rear of 4-section machine showing individual control drums. Left: One dram and one gallon.

New Glass Polishing Compound

ZIRCONIUM OXIDE

for better, faster polishing at lower cost.

EFFECT OF SLURRY CONCENTRATION ON THE POLISHING SPEED USING SPECTACLE CROWN LENSES UNDER 8 PSI WITH PITCH FELT PAD ROTATING AT 168 RPM



TAM Zirconium Oxide is producing excellent results in a variety of commercial optical glass polishing applications. Its polishing action equals highest standards attained with substantial savings in material cost and polishing time. The use of ZrO_2 contributes greatly to cleanliness . . . an important factor in precision work. Working conditions are improved through elimination of discoloration common to the use of rouge.

Volume production experience in optical and glassware applications substantiates all claims made for efficiency, economy and other benefits. Complete details are available upon request to our New York office.

TAM PRODUCTS

TAM is a registered trademark.

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MECHANIZATION OF THE GLASS INDUSTRY . . .

(*Continued from page* 216)

and the evolution occurred as they did, as there is no category within the limitation of human intelligence to determine the *whys* of human action. However, we have attempted to show, by numerous examples, that we have validated a theory or basic law of evolution that progress is accomplished by following this law defined as "Efficiency in the Movement of Materials".

We have also attempted to show, conversely, that failure to follow this law has retarded or stopped or even reversed the path of progress. We have intimated that this is a universal law applicable to all industrial progress and in an even broader sense to evolutionary progress in plant and animal life as well.

To cite an example of the latter consider the diplodicus, that enormous pre-historic animal. He was unable to get enough browse or food to supply sufficient energy to move his heavy body and died of starvation. Glass manufacturers are not particularly interested in the story of the diplodicus. Probably it might be well if they were, because it was precisely the failure to know his story and its application to their industry that caused the decline of two of our greatest glass making empires.

In adopting this law to the glass industry which is a capital, profit and loss, dollar economy, we used the yardstick of dollar cost to measure efficiency. This is artificial and arbitrary but does not alter the working of this law enough to make any real difference in validating action of this law. Progress is essentially movement, a series of steps, and this dollar yardstick measures the rate as well as the direction of progress by cost comparison between steps. These comparisons sometimes involved other considerations, such as differences in quality, and for conformity, we used the factor of "Interpretative Limitations" which was present in some of the events recorded.

The proper evaluation of this modifying factor was evident and important in some cases, but this is mainly important in *evaluating* the basic law. The fall of the two glass making empires in our story was due partly to overvaluation of the factor of "Interpretative Limitations", but mainly to a seeming disregard of the basic law which was the actual determinant.

Conclusions

The past is gone. Its successes and failures alike are as so much water over the dam. The story as told will, I hope, be of some interest, but unless it does more than that, it will fall short of values I have attempted to create.

Progress will go on, and while hindsight is easy to acquire, it is my hope that the theory developed here of a basic law of progress will not only shed some light on the events of the past but, more important, on the consideration of some steps in the progress of glass making in the future.

• The second annual National China, Glass and Pottery Show will be held at the Hotel New Yorker July 16-21.

• DESIGN
• ERECTION
• OPERATION

of Glass Plants

DOMESTIC AND FOREIGN

Complete Glass Plants and equipment, Batch Systems, Furnaces, Batch Feeders, "Liberty" Gob Feeders, Automatic Handling Equipment, Stackers, Lehrs, Machines, etc. for manufacture of flat glass, tubing, pressed and blown ware.

ARTHUR W. SCHMID COMPANY
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A.C.S. METROPOLITAN SECTION MEETING

The final Spring meeting of the Metropolitan Section of The American Ceramic Society was recently held with an attendance of fifty-eight. As has been the custom this year, a "double barreled" program was held with two related talks.

The first speaker was V. H. Remington of the B. F. Drakenfeld Company who discussed the many methods of decorating glass, illustrating his talk with interesting lantern slides. The second speaker was T. G. O'Leary of the Corning Glass Works who explained the development of "Photo Sensitive Glass" and the many uses to which this new medium may be employed. Both speakers furnished interesting displays to illustrate their talks.

Dr. M. D. Rigterink, Chairman of the Nominating Committee, presented the following slate of officers for the coming year: R. F. Doran, Chairman; F. W. Miller, Vice Chairman; F. J. Fallon, Secretary-Treasurer; G. H. Jeffrey and W. W. Coffeen, Councillors. The Program Committee for next season will be Dr. M. D. Rigtering, Chairman; and Dr. J. Gallup, G. Lane, S. J. McDowell and W. W. Roff.

PITTSBURGH CORNING ADDS TO GLASS BLOCK LINE

The Pittsburgh Corning Corporation has announced that seven new PC glass blocks, the "55" line, are now available commercially. The new blocks represent the very latest developments in the field. They permit a more uniform panel appearance and result in better brightness control, according to the company's report.

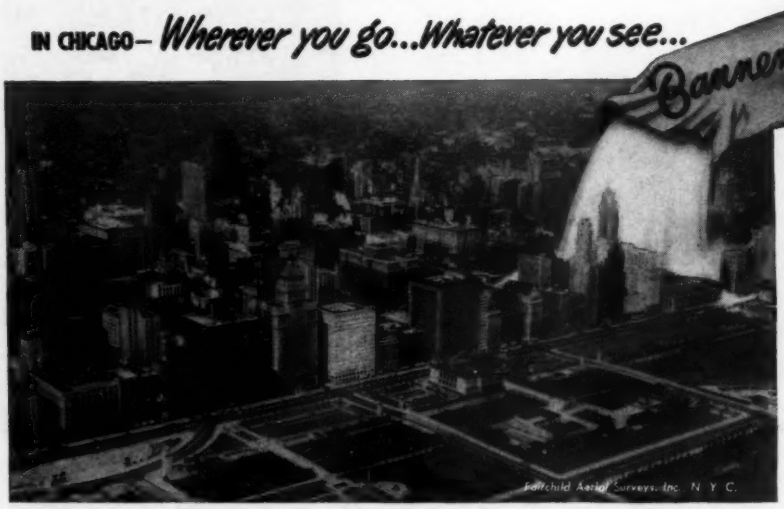
Functional features of the new blocks include Pittsburgh Corning's exclusive Soft-Lite edge treatment (opal glass fused into the block junction to diffuse light which would otherwise be transmitted directly through the block edge thus creating a uniformly soft and comfortable panel appearance), a fibrous glass insert used to further diffuse light transmitted by the block itself, and light-directing prisms on the interior faces of certain patterns. Some blocks are designed for use on south elevations, others for north elevations. Light-directing blocks and light-diffusing blocks are available for these special applications. In addition to the functional qualities of the "55" blocks, a brand new face pattern has been added.

GLASS FACTORY DESIGN AWARDS

Two students in the Carnegie Institute of Technology School of Architecture received cash prizes from The Rust Engineering Company for exceptional handling of problems involved in designing modern plants for the production of window glass.

Casimir J. Pellegrini, Jr., of Pittsburgh, Pa., was awarded first prize of $100 and Robert T. Stevens of Carnegie, Pa., was awarded the $50 second prize. The winning students, both sons of architects, submitted designs of glass factories suitable for a Pittsburgh site and capable of producing 200 tons of flat window glass per day. Both designs were cited by the judges' panel for excellent handling of raw materials, production flow, ventilation of furnace building and arrangements of glass cutting booths, warehousing, and personnel and administrative facilities.

IN CHICAGO— *Wherever you go...Whatever you see...*



is in the picture!

Since 1907, when Banner Lime was first produced, it has been an essential element in Chicago's picture. Banner Lime has been used in many of Chicago's buildings—including the Merchandise Mart, the Civic Opera Building, Wrigley Building, the Board of Trade Building, the McGraw-Hill Building and other well known structures.

Banner Lime is also a basic material used on the farms and by the industries of Illinois.

CHICAGO IN TODAY'S PICTURE: Known as the Windy City, scene of two World's Fairs (1893 and 1933), home of the largest building of its kind in the world (the Merchandise Mart), site of America's first Planetarium—Chicago today is the country's greatest railway center, greatest grain market and greatest livestock market and meat packing center in the world. The entire length of the city borders on beautiful Lake Michigan.

Essentially yours
Banner Lime
FAMOUS OHIO DOLOMITE

NATIONAL MORTAR & SUPPLY COMPANY
First National Bank Building Pittsburgh 22, Pa.
Established 1907

REMARKS ON QUALITY CONTROL . . .

(*Continued from page* 178)

the method of handling, provides a convenient lot for sampling and re-inspection. The size of the sample which is used to determine if re-inspection is to be made and the number of allowable off-specification units to maintain the requisite quality level can be determined from tables such as those published by Dodge and Romig.[1]

In many container plants, the inspectors serve also as packers. It is worthwhile to consider if the inspection function can be reduced or eliminated by the use of statistical quality control methods. The same technique suggested for application to re-inspection could be applied to primary inspection. One method of operation would be to pack all ware, except that obviously off-standard (broken, for instance), take samples from the packed ware, and give certain lots 100% inspection as indicated by the sample. Such a procedure would involve removal from carton for the sampling and for whatever 100% inspection is necessary. A modification would consist of designation of lots from position on the lehr belt, and carrying out the sampling and inspection before the ware reaches the packer. It could be determined from the sample examination if the lot of ware is to be packed or given 100% inspection before packing. A third method has been offered by Dodge[2] as being particularly applicable to inspection in a continuous process. This method does not require a knowledge of quality of product being submitted to inspection in order to operate efficiently. The procedure represents a combination of 100% inspection and inspection by sample. The conditions under which either of these inspection methods is to be used has been worked out by Dodge.

It is impossible to make a sound recommendation with respect to institution of statistical quality control without a study of the specific process. Grant[3] says that if a sampling plan of inspection does not require the 100% inspection of more than one lot in ten, it is likely that the cost of the use of such plan will be less than the cost of carrying out complete 100% inspection. If more than 10% of the lots have to be given full inspection, a more careful consideration of the possibilities must be given.

At the present time, it does not appear that statistical quality control will be feasible for inspection of all glass container production. The incentive would be much greater if automatic packing machines of sufficient universality were employed to place the ware in cartons. The most promising fields, under current conditions, would seem to be the use of control by variables (measurements) at the machine and the control by attributes of packed ware to determine necessity of re-inspection. These apply to particularly critical items or critical dimensions. Inspection by sampling for jobs easily produced may reduce the cost of inspection of these. Aside from these two fields, the study of the application of statistical treatment to measurements already being taken should be considered.

The use of statistical quality control, even though this

[1] H. F. Dodge and H. G. Romig "Sampling Inspection Tables". Wiley New York. 1944.

[2] H. F. Dodge "A Sampling Plan for Continuous Production." The Annals of Mathematical Statistics. 14, 264-279, Sept. 1943.

[3] E. L. Grant "Statistical Quality Control." McGraw-Hill, New York 1946. pg. 383.

Cleaner Glass, Low Maintenance with **CRYSTALITE Forehearths**

REMMEY CRYSTALITE (mullite-bonded mullite) is produced in all shapes necessary to make up the forehearth assembly. Burner blocks, cover blocks, channels, spouts, tubes, plungers and orifice rings are built to meet specified requirements. These CRYSTALITE parts mean better, more efficient production by offering:

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Dependable Refractories

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use may be limited, will demonstrate what confidence can be placed in it as well as giving the experience needed for extension of the application. Its success in other, similar, fields should encourage the glass manufacturer to investigate possible application for the improvement of quality or performance in his own factory.

A.C.S. ANNUAL MEETING . . .

(*Continued from page* 182)

through a slide wire rheostat to a bridge type recorder. A standard deviation of ±22°C. for compression failure and ±24°C. for tensile failure was determined on a periclase refractory.

Wednesday Morning, April 26, 1950
9:00 A.M.-12:00 M.
Georgian Room

13. Preparation, Structure and Applications of Thin Films of Silicon Monoxide and Titanium Dioxide. *By George Hass, Engineer, Research and Development Laboratories, Fort Belvoir, Va.*

A material satisfying the chemical formula for silicon monoxide can be prepared by heating finely divided silicon and silica in vacuum. Silicon monoxide is structurally different from either silicon or silicon dioxide and exists only in amorphous form. It becomes decomposed to silicon and silica by heat treatment in an inert atmosphere and oxidizes to silica when heated in air. Unlike silicon dioxide silicon monoxide absorbs strongly in the ultraviolet. The increase in ultraviolet transmission of silicon monoxide films in air at various temperatures has been used to measure their oxidation to silica. The relatively low temperature at which silicon monoxide evaporates, its amorphous structure, and the good chemical and mechanical resistance of thin films of this material make it especially suitable for preparing protective layers on front surface mirrors and replica and support films for electron microscope and electron diffraction studies. Titanium dioxide films prepared by evaporating titanium and oxidizing it in air at 400° to 450°C. have rutile structure. The rutile films have a refractive index of about 2.7 and can be used for producing extremely durable beam splitters without light losses for increasing the reflectivity of front surface mirrors.

Wednesday Afternoon, April 26, 1950
2:00-5:00 P.M.
Georgian Room

15. A Simple and Inexpensive High-Temperature Dilatometer. *By John M. Mochel, Research Dept., Corhart Refractories Co., Louisville, Ky.*

The construction of a simple and inexpensive high temperature dilatometer is described. The economy of construction places its cost within limits of a small laboratory budget. It does not require a skilled operator. Suggestions are made for increasing the accuracy.

18. The Resistance of Refractories to Certain Lead Compounds. *By A. Paul Thompson, Director of Research, and W. J. Clapson, Head of development section, Eagle-Picher Co. Research Laboratories, Joplin, Mo.*

Very little has been published as to the behavior of refractories when exposed to the action of lead-containing compounds. The work described in this paper was undertaken with the intention of overcoming this lack of specific information. The problem was proved more complicated than at first anticipated. Therefore the present paper is primarily a progress report.

The test equipment in its present state of development is described. Photographs of certain of the refractories tested

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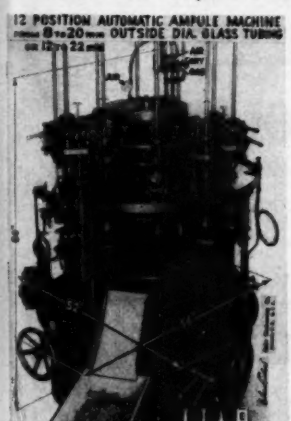
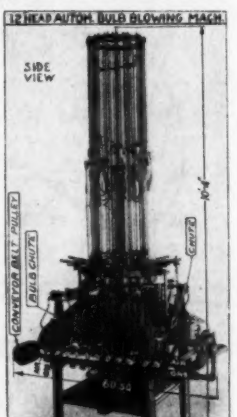
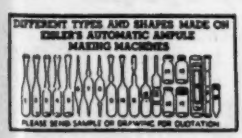
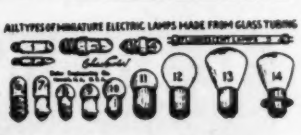
Automatic Glass Machinery
For the Manufacture
of Incandescent Lamps and All Types of Electronic Tubes






DIFFERENT TYPES AND SHAPES MADE ON EISLER'S AUTOMATIC AMPULE MAKING MACHINES
PLEASE SEND SAMPLE OR DRAWING FOR QUOTATION



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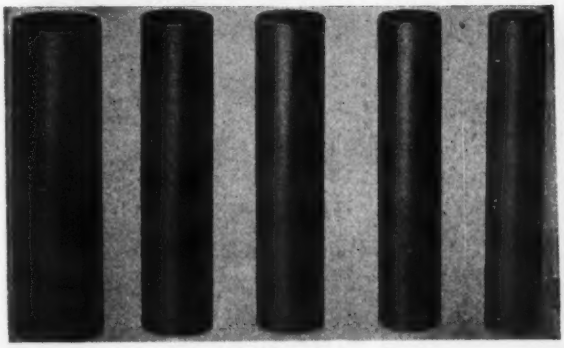
GUNITE



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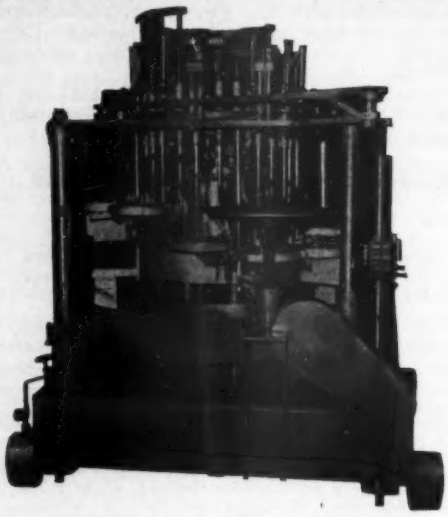
AUTOMATIC BURN-OFF MACHINES



AUTOMATIC HIGH SPEED OPERATION
ON LARGE OR SMALL BLOWN WARE

Write for Bulletin AB49

STEWART-GLAPAT CORPORATION
ZANESVILLE, OHIO

FIRE POLISHERS • CONTAINER FINISHERS • THE UNIVERSAL LEHR LOADER • ADJUSTOVEYOR GLASS CONVEYORS

and thin sections illustrating the mechanism of attack as carried out at the interface are shown.

In general, and as would be expected, a basic refractory with a high magnesia content best resists the attack of lead-containing compounds.

DESIGN DIVISION PROGRAM
Tuesday Morning, April 25, 1950
9:00 A.M.-12:00 M.
Parlor 1

5. Design of Steuben Glass. *By John Montieth Gates, Director of Design, Steuben Glass, Inc., New York, N. Y.*

Theories and principles used in the design of Steuben Glass are presented and supplemented by photographic slides.

Tuesday Afternoon, April 25, 1950
2:00-4:00 P.M.
Parlor 1

8. What's Wrong with the Promotional Technique in China and Glassware. *By Lillian Weiss, Editor, Crockery and Glass Journal, New York, N. Y.*

An analysis of the present-day market shows that even though the dollar volume of china and glassware sales far exceeds that of women's coats and suits, the promotional and advertising efforts behind ceramic wares fall far short.

Wednesday Morning, April 26, 1950
9:00 A.M.-12:00 M.
Parlor 1

11. Design in Industry. *By Theodore S. Jones, Director, Department of Design in Industry, Institute of Contemporary Art, Boston, Mass.*

2:00-5:00 P.M.

14. The Hand Arts in an Industrial Age. *By Mrs. Vanderbilt Webb, President, American Craftsmen's Cooperative Council, Inc.*

AMCO

Design, Erection
and Operation
of
Manufacturing Plants
and
Furnaces
for
All Types
of
GLASS WARE

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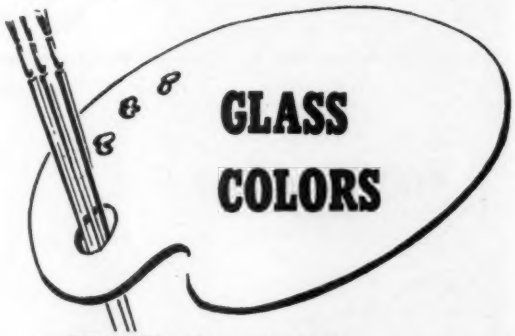
CORPORATION
CHAMBER OF COMMERCE BUILDING, PITTSBURGH 19, PA.



The Entire Pallet
Acid Resistant
Alkali Resistant
Transparent, Opaque

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PITTSBURGH 30, PENNA.

OPTICAL SOCIETY MEETING . . .

(*Continued from page* 195)

the factors which enters into both vision and color vision. We continually add to our experiences of seeing, so that when we see something which we have not seen before, we immediately interpret it, without realizing it, in terms of our past experiences.

The Inter-Society Color Council cuts across a great field of professional people, many of whom have little in common except their interest in color problems. Many of their problems are tied up in the fact that they have different concepts of color and speak different languages. The organization strives to bring mutual understanding to the members in order that they can better work together.

NEW SAFETY TRAINING FILM AVAILABLE FROM SAFETY COUNCIL

A new safety training film has just been announced by the National Safety Council. Titled "Easy on the Eyes", the film opens on an emotional appeal for workers to realize what their eyes mean to them, then shows how easily eyesight may be lost and that such loss is personal. The film shows what glasses are best for specific jobs, presents case histories of injured workers and the dramatic testimony of blind persons.

Three rules set the theme of the film: wear the right safety glasses, make sure they fit and keep them clean. The film is available from the National Safety Council in the usual 35mm sound slidefilm, but it is also offered in a new form for 16mm sound-motion projectors.

The New Danner

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Continuous Tanks or Day Tanks

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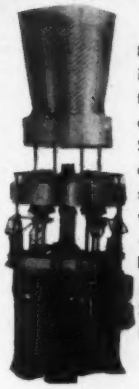
For Soft Glass, Chill Cut



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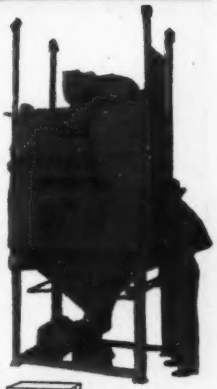

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